Commercial Mortgage-backed Securities (CMBS) Terminations, Regional and Property-Type Risk*

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Abstract

Option theory predicts that mortgage default or prepayment will be exercised if the call or put option is "in the money." We extend our analysis to commercial mortgages using data from commercial mortgage-backed securities (CMBS). The paper presents a model of the competing risks of mortgage termination (default and prepayment) using data from commercial mortgage-backed securities (CMBS) deals.

Our results show that the option model explains both default and prepayment for commercial mortgages. We find that loan specific variables (such as loan-to-value ratio, debt service coverage ratio, loan-rate spread and prepayment prevention) are important explanatory variables for both default and prepayment. We also find that default and prepayment vary across regions of the country; given that regional economies do not move in perfect lock-step, we would expect there to be cross-sectional variation in default rates. However, the degree of variation across regions in terms of prepayments is not as predictable. The largest differences are across property types, both in terms of default and prepayment risk.

Keywords: Mortgage default, prepayment, termination, mortgage pricing, commercial mortgages.

1. Introduction

The securitized commercial mortgage-backed securities (CMBS) market has grown dramatically since 1980s. CMBS annual issuance in the U.S. has grown from less than $1 billion in 1985 to $169 billion in 2005. This growth in issuance has resulted in of $550 billion of CMBS outstanding at the end of 2005 (or approximately 21 percent of $2.6 trillion commercial mortgages outstanding). However, much of our knowledge of CMBS prepayment and default comes from empirical work on (unsecuritized) commercial mortgages originated by life insurance companies rather than securitized commercial mortgages.

A number of prior studies have examined commercial mortgage default and prepayment experience (see, for example, Vandell (1992), Follain et al (1997), Archer et al (2001) and Ciochetti et al (2002)). Typically, these papers have used commercial mortgage data from life insurance companies, financial institutions and government agencies. While these studies have contributed greatly to our understanding of prepayment and default behavior of commercial mortgages, we can extend our understanding of commercial mortgage termination behavior by examining loans from a broader set of lenders.

In this paper, we examine termination on commercial loans found in commercial mortgage-backed security (CMBS) deals. We employ an econometric model of commercial mortgage defaults and prepayments based on option pricing theory in order to determine if option pricing theory correctly prices the default and prepayment options embedded in commercial mortgages. In particular, we are interested in examining how prepayments and defaults vary across property-types and regions. Stated differently, can

a portfolio manager gain more from diversifying across property-types or geographic regions?

Commercial mortgage and CMBS termination is discussed in Section 2. We discuss our methodology in Section 3. The data is discussed in Section 4 and our findings are presented in Section 5. Our next steps in the research agenda are presented in Section 6.

2. Commercial Mortgage and CMBS Termination

A number of early studies of commercial mortgage termination concentrated on life insurance company and government agency data. Vandell et al. (1993) found that default probabilities increased gradually with increases in the loan-to-value ratio (LTV). Follain, Ondrich and Sinha (1997) found that there was not "ruthless default" in terms of instantaneous exercise of the default option. Ciochetti and Vandell (1999) extend this previous work by examining agency mortgages. It is important to observe that these paper were not competing risk models of termination (between prepayment and default), as single events and not competing risks.

For our papers, an important paper is Deng, Quigley, and Van Order (2000). In that paper, they created an empirical model where prepayment and default are competing risks. Although Deng, Quigley and Van Order (2000) examined residential mortgages, their study finds that the competing risks approach is important in explaining loan termination. Specifically, initial LTV was found to be significant in explaining both prepayment and default.

Ambrose and Sanders (2003) were the first to apply this competing risk empirical model to study a broader set of commercial mortgages; they were also the first to apply a competing risks model to CMBS loans. Their study finds no effect of initial LTV, but they argue that this could be due to endogeneity. Archer, Elmer, Harrison, and Ling (2002) also found that initial LTV had little explanatory effect on default (although they used agency rather than CMBS data).

Recent empirical papers on commercial loan terminations using CMBS data include Seslen and Wheaton (2005) and Yildirim (2005). Seslen and Wheaton (2005) find that the probability of default is extremely low even at very high levels of stress suggesting substantial lender forbearance and a possible reluctance to foreclose. Yildirim (2005) finds substantially higher probabilities of default than Ambrose and Sanders (2003) and Seslin and Wheaton (2005).

3. Methodology

The Cox proportional hazard model has recently become the most popular technique in mortgage performance studies. 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 loan may be unexpectedly terminated due to default or prepayment, which can also be considered as survival failure, the model has been conveniently borrowed by mortgage researchers to estimate the determinants of the mortgage's time to default or prepayment. In particular, the model estimates the probability that a mortgage associated with certain characteristics may default or prepay in a given period given the fact the mortgage is still active at the beginning of the period, which is also called the

conditional probability of default and prepayment. Cumulative prepayment risks can then be easily computed from the estimated conditional prepayment rate (CPR). Similarly, we can compute cumulative default risks from the estimated conditional default rate (CDR).

Green and Shoven (1986) are among the first to apply the Cox proportional hazard model to study residential mortgage prepayments due to interest rate movements. Since then, researchers have developed more sophisticated and realistic applications of the Cox proportional hazard model to study mortgage termination behaviors. For example, Schwartz and Torous (1989) developed a contingent claim framework for valuation of GNMA mortgage-backed securities through the integration of an empirical Cox proportional hazard model to estimate the aggregate GNMA mortgage pools prepayment experience. Stanton (1995) extends the Schwartz and Torous (1989) model by allowing transaction cost of prepayment in the modeling of mortgage pools' rational prepayment behavior. Deng, Quigley and Van Order (2000) model the competing risks of mortgage termination in a proportional hazard framework which allows correlated competing risks and accounts for the unobserved heterogeneity as discrete mass points. Deng and Quigley (2002) model unobserved heterogeneity as a continuous distribution.

The hazard function of the Cox model is defined as the product of a baseline hazard function and a set of proportional factors such that

$$h\left(t_{ij}; z_j\left(t_{ij}\right)\right) = h_{0j}\left(t_{ij}\right)\exp\left(z_j\left(t_{ij}\right)'\beta_j\right), \quad j = 1, 2, 3 \tag{1}$$

where $h_{0j}\left(t_{ij}\right)$ is a baseline hazard function that describes the overall shape of the mortgage termination risks by borrowers' prepayment or default decision; $z_j\left(t_{ij}\right)$ is a vector of proportional factors capturing time-varying or time-invariant covariates. These covariates reflect market values of the financial options as well as other

financial/economic market variations and mortgage borrowers' characteristics; *j* indicates prepayment (if *j*=1) or, default (if *j*=2) event. *j*=3 indicates the loan is still active.

A popular estimation approach for the proportional hazard model is known as the *Cox Partial Likelihood* estimation, which only requires the existence of a common stationary baseline hazard function, h_0, for all subjects. This approach estimates the coefficients for the proportional factors based on rank and order statistics (hence called *Partial Likelihood*). So β can be identified without parametric restrictions on the baseline function since $h_0(t)$ is concentrated out as a nuisance factor. 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.

In this draft, we adopt the Cox partial likelihood approach to identify major determinants of the commercial mortgage prepayment and default risks. We control for both time-invariant and time-varying covariates. The time-invariant covariates include original loan-to-value ratio, debt-service coverage ratio, rate spread at origination, various prepayment protection indicators, etc. State unemployment rate is a time-varying covariate measured at the termination point (i.e., either a loan is terminated by default or prepayment or is censored). In addition, we also control for regional fixed effects in prepayment and default.

4. Data

The majority of studies regarding commercial mortgage prepayment and default have employed databases from life insurance companies, banks and government agencies. Following Ambrose and Sanders (2003), we employ a database composed of commercial

mortgage found in CMBS deals which contain information on commercial mortgages that have been securitized and traded publicly. Our data was obtained from Intex, a leading provider of historical cash flow, prepayment and default data for mortgage- and asset-backed securities. The data that Intex gathers comes from monthly servicing company remittance reports which are then used to form databases for each CMBS deal.

From the Intex database, we are able to form a database of time series observations on commercial mortgage termination outcomes: prepayment, delinquency and default.[1] The database includes loan specific data such as loan-to-value ratio (LTV), debt service coverage ratio (DCR), original balance, current balance, gross coupon, net coupon, amortization period, property type, location of underlying property, prepayment provisions, originator, syndicator, and servicer (both master and special).

The advantage of the CMBS database for our purposes is that it contains loan information for a large number of CMBS originators (Southern Pacific, Allied, GMAC, Confederation Life, Midland, Keybank, Nomura), master servicers (Capmark, Midland ORIX) and special servicers (ORIX, Lend Lease, Archon). The result is that we have a broader representation of loans than many of the other commercial mortgage studies using a single life insurance company, bank or government agency.

The disadvantage of the CMBS database is that the time series is not as long as the databases from certain life insurance companies or banks. Also, the other databases may contain additional information that is not reported to in the servicing reports.

The size of our sample by property type is presented in Table 1. There are 37,542 commercial loans in the sample. The largest property type represented in the sample is

[1] We use 60 days delinquent as a proxy for default. It is important to observe that loans going beyond 60 days can be resumed. Therefore, our measure of default is really of measure of 60 day delinquency, which is still of interest to investors.

multifamily housing loans at 33% of the sample. The size of the multifamily housing loan sample would have been substantially larger had we included loans from Fannie Mae, Freddie Mac and Ginnie Mae. These multifamily housing loans were excluded since the vast majority of these loans had little or no loan specific characteristics reported. The second highest property type representation in the sample is retail property loans with 26% followed by office properties loans with 15%.

The origination dates are listed in Table 2. We excluded any loan originated before January 1, 1996 because of data inconsistencies. In additional, we excluded any loan originated after December 31, 2001 since the loans originated after this date would not be sufficiently seasoned to experience a termination event. The greatest number of commercial mortgages was originated during 1998.

The descriptive statistics for the sample are presented in Table 3. The average original balance on the commercial loans is $6,733,220. The average original loan-to-value (LTV) ratio at origination is 68.7%. The average debt service coverage (DCR) ratio is 1.70. The majority of commercial mortgages were amortized over 30 years with a balloon payment due after 10 years. The majority of commercial loans had some form of prepayment protection for 5 years.

The regions where the loans were originated is presented in Table 7. The largest percentage of the loans was originated in the Southern/Atlantic region (19%). The second and third largest regions for origination are the Western/Southern region (13%) and the Northeast/Mid-Atlantic region (12%), respectively. We include loan size as well as contemporaneous LTV (as measured by a property's current loan amount outstanding divided by the original property value adjusted over time by the NCREIF index.

The default outcomes of the loan sample are presented in Table 9. We define a "default" as being 60 days delinquent. While this is not the legal definition of default, 60 days delinquent is the trigger for the special servicer to intervene indicating that there is evidence of financial distress. For the sample, 3.59% of the loans experienced delinquencies of 60 days or more. Interestingly, the major property type (Multifamily, Retail, Office and Industrial) experienced serious delinquencies of less than the average of 3.59%. It is the remaining property types (self-storage, healthcare) that suffered the highest delinquency problems.

In Tables 10-12, we present the Cox partial likelihood estimates. Tables 10-12 vary be the inclusion of variables representing loan terms. Table 10 includes the original LTV. Table 11 includes the original LTV and the yield spread on the mortgage at origination. Table 12 includes the original LTV, the yield spread on the mortgage at origination and the initial debt coverage ratio. We examine these alternate specifications in order to see if the potential endogeneity problem between initial LTV, yield spread and debt service coverage ratio impacts the results.

To facilitate the empirical tests, we created a loan state matrix where we track the loan from its beginning to its termination (if it terminates). The loans may be active or terminated. Active loans include those that are current as well as overdue (e.g., some loans can run 30 days overdue for several months). The terminated loans include those that have prepaid, paid-off at maturity or have gone into foreclosure and REO. The number of loans that reached 60 days delinquent and returned to active status are less than 1% of the loans that go 60 days delinquent.

5. Findings

Table 10 reports the estimated commercial mortgage loans prepayment and default risks by different underlying property types. We find that default, in the aggregate, is explained by the loan parameters, LTV, DSCR and rate spread. Interestingly, we find that LTV has a positive but insignificant sign (see Elmer et al (2002) and Ambrose and Sanders (2003) for discussions of the relationship between LTV and default). Origination spread has a positive sign and is significant (see Table 11). The debt service coverage ratio is positively signed which is expected (see Table 12), but inclusion of all three variables in the model results in a sign change for yield spread.

In terms of regional dynamics for default and prepayment, we use the state unemployment rate as a time-varying covariate measured at the termination point (i.e., either a loan is terminated by default or prepayment or is censored). The state unemployment rate variable is positively signed and significant.

Prepayment is satisfactorily explained by the variables measuring prepayment protection. Once again, the rate spread variable is positive and significant indicating that commercial mortgages whose spread is higher are more likely to prepay, ceteris paribus.

The regional dummy variables offer interesting insights into default and prepayment behaviors for commercial mortgages. In the aggregate, there are differences in the coefficient magnitudes across regions. However, the biggest difference in terms of default and prepayment behaviors are across property-types. The property types with the highest default risk also have the lowest prepayment risk (and vice versa).

6. Conclusions

We find that default (as measured by 60-day delinquency), in the aggregate, is explained by the loan parameters, LTV, DSCR and rate spread. Furthermore, we find rather dramatic variations in default and prepayment behavior across property-types, but less so across regions. As with Archer, Elmer, Harrison and Ling (2001) and Ambrose and Sanders (2003), the sign for initial LTV is zero and insignificant for default. However, the contemporaneous measure of LTV for default is positive and significant.

The important conclusion for researchers is that fixed-income portfolio managers can gain greater diversification benefits by diversifying across property types than diversifying across regions. The property types with the highest default risk also have the lowest prepayment risk (and vice versa).

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TABLE 1 – SAMPLE BY PROPERTY TYPE

Property type	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Healthcare	705	1.88	705	1.88
Hotel	2293	6.11	2998	7.99
Industrial	3242	8.64	6240	16.62
Manufactured housing	1205	3.21	7445	19.83
Multifamily	12258	32.65	19703	52.48
Office	5457	14.54	25160	67.02
Other	1392	3.71	26552	70.73
Retail	9921	26.43	36473	97.15
Self Storage	1069	2.85	37542	100.00

TABLE 2 – ORIGINATION YEAR

	All property types		Multifamily		Retail		Office		Industrial		Other	
Origination Date	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Origination Date in 1996	3404	9.07	1573	12.83	764	7.7	226	4.14	218	6.72	623	9.35
Origination Date in 1997	6477	17.25	2363	19.28	1703	17.17	642	11.76	466	14.37	1303	19.55
Origination Date in 1998	12393	33.01	3914	31.93	3287	33.13	1793	32.86	1030	31.77	2369	35.55
Origination Date in 1999	5400	14.38	1694	13.82	1429	14.4	823	15.08	535	16.5	919	13.79
Origination Date in 2000	4437	11.82	1117	9.11	1253	12.63	924	16.93	444	13.7	699	10.49
Origination Date in 2001	5431	14.47	1597	13.03	1485	14.97	1049	19.22	549	16.93	751	11.27
SUM	37542	100	12258	100	9921	100	5457	100	3242	100	6664	100

TABLE 3 – DESCRIPTIVE STATISTICS

Variable	Mean	Std Dev
Original LTV	68.61	11.63
Debt Service Coverage Ratio	1.70	1.25
Original Balance	6,733,220	18,552,762
Gross Coupon	7.87	0.95
Net Coupon	7.76	0.95
Lock Out Months	62	51
Yield Maintenance Months	28	44
Prepay Penalty Months	3	16
Amortization Term	314	70
Maturity Term	134	55

TABLE 4 – ORIGINAL LOAN-TO-VALUE RATIO

	All property types		Multifamily		Retail		Office		Industrial		Other	
Original LTV	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
0% <LTV<= 10%	101	0.27	84	0.69	4	0.04	5	0.09	1	0.03	7	0.11
10% <LTV<= 30%	388	1.03	204	1.66	51	0.51	37	0.68	32	0.99	64	0.96
30% <LTV<= 50%	2137	5.69	452	3.69	432	4.35	408	7.48	220	6.79	625	9.38
50% <LTV<= 70%	14206	37.84	3346	27.3	3569	35.97	2441	44.73	1431	44.14	3419	51.31
70% <LTV<= 80%	19238	51.24	7660	62.49	5249	52.91	2484	45.52	1492	46.02	2353	35.31
80% <LTV<= 90%	1023	2.72	499	4.07	302	3.04	59	1.08	34	1.05	129	1.94
90% <LTV<=100%	449	1.2	13	0.11	314	3.17	23	0.42	32	0.99	67	1.01
Missing	0		0		0		0		0		0	
SUM	37542	100	12258	100	9921	100	5457	100	3242	100	6664	100

TABLE 5 – GROSS COUPON

	All property types		Multifamily		Retail		Office		Industrial		Other	
Gross Coupon	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
0 <Gross coupon<= 5%	479	1.28	54	0.44	84	0.85	157	2.88	17	0.52	167	2.51
5% <Gross coupon<= 7%	4025	10.72	1827	14.9	976	9.84	484	8.87	294	9.07	444	6.66
7% <Gross coupon<= 9%	29573	78.77	9323	76.06	8147	82.12	4511	82.66	2732	84.27	4860	72.93
9% <Gross coupon<= 12%	3430	9.14	1052	8.58	711	7.17	298	5.46	194	5.98	1175	17.63
12% <Gross coupon	35	0.09	2	0.02	3	0.03	7	0.13	5	0.15	18	0.27
Missing	0		0		0		0		0		0	
SUM	37542	100	12258	100	9921	100	5457	100	3242	100	6664	100

TABLE 6 – GROSS COUPON BY YEAR

	1996		1997		1998		1999		2000		2001	
Gross Coupon	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
0 <Gross coupon<= 5%	2	0.06	17	0.26	16	0.13	52	0.96	219	4.94	173	3.19
5% <Gross coupon<= 7%	11	0.32	44	0.68	2961	23.89	218	4.04	78	1.76	713	13.13
7% <Gross coupon<= 9%	2101	61.72	5138	79.33	9188	74.14	4944	91.56	3735	84.18	4467	82.25
9% <Gross coupon<= 12%	1278	37.54	1268	19.58	226	1.82	185	3.43	397	8.95	76	1.4
12% <Gross coupon	12	0.35	10	0.15	2	0.02	1	0.02	8	0.18	2	0.04
Missing	0		0		0		0		0		0	
SUM	3404	100	6477	100	12393	100	5400	100	4437	100	5431	100

TABLE 7 – LOANS BY REGION

	All property types		Multifamily		Retail		Office		Industrial		Other	
Region	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Midwest / Eastern	3385	9.02	1128	9.2	994	10.02	456	8.36	295	9.1	512	7.68
Midwest / Western	1348	3.59	541	4.41	342	3.45	166	3.04	85	2.62	214	3.21
Northeast / Mid-Atlantic	4423	11.78	1467	11.97	1108	11.17	816	14.95	415	12.8	617	9.26
Northeast / New-England	1768	4.71	469	3.83	496	5	348	6.38	161	4.97	294	4.41
Southern / Atlantic	7098	18.91	2094	17.08	2259	22.77	1018	18.65	475	14.65	1252	18.79
Southern / East-Coast	1121	2.99	389	3.17	342	3.45	118	2.16	40	1.23	232	3.48
Southern / West-Coast	4655	12.4	2335	19.05	1076	10.85	453	8.3	226	6.97	565	8.48
Western / Mountain	3550	9.46	1157	9.44	1010	10.18	457	8.37	251	7.74	675	10.13
Western / Northern Pacific	3274	8.72	840	6.85	605	6.1	668	12.24	386	11.91	775	11.63
Western / Southern Pacific	5001	13.32	1496	12.2	1252	12.62	753	13.8	667	20.57	833	12.5
NA	1919	5.11	342	2.79	437	4.4	204	3.74	241	7.43	695	10.43
SUM	37542	100	12258	100	9921	100	5457	100	3242	100	6664	100

TABLE 8 – PREPAYMENT CONSTRAINTS

Prepayment Constraint	Frequency	Percent	Cumulative Frequency	Cumulative Percent
No constraint	2012	5.36	2012	5.36
With one type (Lock out or yield maintenance, or prepayment penalty)	23253	61.94	25265	67.3
With two types	11846	31.55	37111	98.85
With three types	431	1.15	37542	100

TABLE 9 – 60 DAYS LATE BY PROPERTY TYPE

	All property types		**Multifamily**		**Retail**		**Office**		**Industrial**		**Other**	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Not Delinquent	36193	96.41	11941	97.41	9582	96.58	5343	97.91	3143	96.95	6184	92.8
60 days Delinquent	1349	3.59	317	2.59	339	3.42	114	2.09	99	3.05	480	7.2
Missing	0		0		0		0		0		0	
SUM	37542	100	12258	100	9921	100	5457	100	3242	100	6664	100

TABLE 10–COX PARTIAL LIKELIHOOD ESTIMATES FOR CMBS MORTGAGE PREPAYMENT AND DEFAULT RISK

	All property type	
	Prepay	Default
Log of original loan balance	-0.12***	-0.03
	(0.03)	(0.03)
Original loan-to-value ratio (LTV)	0.00	0.01
	(0)	(0)
Prepayment option value	2.31***	6.54***
	(0.43)	(0.41)
Default option value	-0.01***	0.06***
	(0)	(0)
State Unemployment Rate	-0.19***	0.05
	(0.03)	(0.03)
Lock Out Term Indicator	-0.66***	0.27**
	(0.06)	(0.1)
Yield Maintenance Indicator	0.12*	-0.09
	(0.06)	(0.06)
Prepayment Penalty Indicator	0.89***	0.27**
	(0.06)	(0.09)
Multifamily	0.81***	-0.33***
	(0.07)	(0.08)
Office	0.40***	-0.21
	(0.1)	(0.11)
Industrial	0.38***	0.14
	(0.11)	(0.12)

Other property type	0.16 (0.09)	0.79*** (0.07)

TABLE 10–COX PARTIAL LIKELIHOOD ESTIMATES FOR CMBS MORTGAGE PREPAYMENT AND DEFAULT RISK (continued)

	All property type	
	Prepay	Default
Midwest / Eastern	0.20 (0.37)	0.28 (0.24)
Midwest / Western	0.27 (0.38)	0.33 (0.26)
Northeast / Mid-Atlantic	0.37 (0.36)	-0.06 (0.25)
Northeast / New-England	0.79* (0.37)	0.07 (0.26)
Southern / Atlantic	0.49 (0.36)	0.16 (0.24)
Southern / East-Coast	0.17 (0.39)	0.61* (0.26)
Southern / West-Coast	0.71 (0.36)	0.26 (0.24)
Western / Mountain	0.62 (0.36)	-0.21 (0.25)
Western / Northern Pacific	0.94* (0.37)	-0.54* (0.26)
Western / Southern Pacific	1.07** (0.36)	-1.04*** (0.26)
Number of Observations	33969	
-2 Log Likelihood	30320.36	25539.45

Schwarz B.I.C.	30483.72	25697.65

Note:

1. Standard errors are in parentheses.
2. Estimates with * are those with P-value < 0.05; ** denotes P-value <0.01 and *** denotes P-value <0.001.
3. Prepayment and default option values are time-varying covariates calculated with prevailing mortgage rate and NACREIF commercial property index using similar method as in Deng, Quigley and Van Order (2000).
4. State unemployment rate is a time-varying covariate measured at the time when the loan is either terminated by prepayment or default or censored.
5. For property type, retail is used as the reference group. Other property type includes Hotel, Manufactured Housing, Self Storage and Healthcare.
6. For regional effect, loans with missing information on region are in the reference group.

TABLE 11–COX PARTIAL LIKELIHOOD ESTIMATES FOR CMBS MORTGAGE PREPAYMENT AND DEFAULT RISK

	All property type	
	Prepay	Default
Log of original loan balance	-0.11***	0.02
	(0.03)	(0.03)
Original loan-to-value ratio (LTV)	0.00	0.01*
	(0)	(0)
Origination spread	0.47	1.97***
	(0.26)	(0.22)
Prepayment option value	2.01***	5.32***
	(0.46)	(0.43)
Default option value	-0.01***	0.06***
	(0)	(0)
State Unemployment Rate	-0.19***	0.05
	(0.03)	(0.03)
Lock Out Term Indicator	-0.65***	0.30**
	(0.06)	(0.1)
Yield Maintenance Indicator	0.12*	-0.05
	(0.06)	(0.06)
Prepayment Penalty Indicator	0.89***	0.25**
	(0.06)	(0.1)
Multifamily	0.82***	-0.28***
	(0.07)	(0.08)
Office	0.39***	-0.23*
	(0.1)	(0.11)

Industrial	0.38***	0.14
	(0.11)	(0.12)
Other property type	0.14	0.71***
	(0.09)	(0.07)

TABLE 11–COX PARTIAL LIKELIHOOD ESTIMATES FOR CMBS MORTGAGE PREPAYMENT AND DEFAULT RISK (continued)

	All property type	
	Prepay	Default
Midwest / Eastern	0.23 (0.37)	0.45 (0.25)
Midwest / Western	0.29 (0.38)	0.47 (0.27)
Northeast / Mid-Atlantic	0.39 (0.36)	0.09 (0.25)
Northeast / New-England	0.81* (0.37)	0.22 (0.26)
Southern / Atlantic	0.51 (0.36)	0.32 (0.24)
Southern / East-Coast	0.18 (0.39)	0.76** (0.26)
Southern / West-Coast	0.73* (0.36)	0.41 (0.24)
Western / Mountain	0.65 (0.36)	-0.03 (0.25)
Western / Northern Pacific	0.97** (0.37)	-0.37 (0.27)
Western / Southern Pacific	1.09** (0.36)	-0.90*** (0.27)
Number of Observations	33969	
-2 Log Likelihood	30316.99	25468.60

Schwarz B.I.C.	30487.77	25633.98

Note:

7. Standard errors are in parentheses.
8. Estimates with * are those with P-value < 0.05; ** denotes P-value <0.01 and *** denotes P-value <0.001.
9. Origination spread is the percent difference of mortgage coupon rate and the 10-year CMT at the time of loan origination.
10. Prepayment and default option values are time-varying covariates calculated with prevailing mortgage rate and NACREIF commercial property index using similar method as in Deng, Quigley and Van Order (2000).
11. State unemployment rate is a time-varying covariate measured at the time when the loan is either terminated by prepayment or default or censored.
12. For property type, retail is used as the reference group. Other property type includes Hotel, Manufactured Housing, Self Storage and Healthcare.
13. For regional effect, loans with missing information on region are in the reference group.

TABLE 12–COX PARTIAL LIKELIHOOD ESTIMATES FOR CMBS MORTGAGE PREPAYMENT AND DEFAULT RISK

	All property type	
	Prepay	Default
Log of original loan balance	-0.11***	-0.01
	(0.03)	(0.03)
Original loan-to-value ratio (LTV)	0.00	-0.01**
	(0)	(0)
Origination spread	0.00	-1.32***
	(0.02)	(0.06)
Debt-service-coverage ratio (DSCR)	0.47	1.73***
	(0.26)	(0.22)
Prepayment option value	2.01***	4.65***
	(0.46)	(0.43)
Default option value	-0.01***	0.06***
	(0)	(0)
State Unemployment Rate	-0.19***	0.06*
	(0.03)	(0.03)
Lock Out Term Indicator	-0.65***	0.23*
	(0.06)	(0.1)
Yield Maintenance Indicator	0.12*	-0.06
	(0.06)	(0.06)
Prepayment Penalty Indicator	0.89***	0.19*
	(0.06)	(0.09)
Multifamily	0.82***	-0.34***
	(0.07)	(0.08)

Office	0.39*** (0.1)	-0.15 (0.11)
Industrial	0.38*** (0.11)	0.16 (0.12)
Other property type	0.14 (0.09)	0.58*** (0.08)

TABLE 12–COX PARTIAL LIKELIHOOD ESTIMATES FOR CMBS MORTGAGE PREPAYMENT AND DEFAULT RISK (continued)

	All property type	
	Prepay	Default
Midwest / Eastern	0.23 (0.37)	0.28 (0.25)
Midwest / Western	0.29 (0.38)	0.35 (0.27)
Northeast / Mid-Atlantic	0.39 (0.36)	0.02 (0.25)
Northeast / New-England	0.81* (0.37)	0.25 (0.27)
Southern / Atlantic	0.52 (0.36)	0.20 (0.24)
Southern / East-Coast	0.18 (0.39)	0.56* (0.26)
Southern / West-Coast	0.73* (0.36)	0.31 (0.25)
Western / Mountain	0.65 (0.36)	-0.17 (0.26)
Western / Northern Pacific	0.97** (0.37)	-0.44 (0.27)
Western / Southern Pacific	1.09** (0.36)	-0.80** (0.27)
Number of Observations	33969	
-2 Log Likelihood	30316.98	24980.14

Schwarz B.I.C.	30495.19	25152.71

Note:

14. Standard errors are in parentheses.
15. Estimates with * are those with P-value < 0.05; ** denotes P-value <0.01 and *** denotes P-value <0.001.
16. Origination spread is the percent difference of mortgage coupon rate and the 10-year CMT at the time of loan origination.
17. Prepayment and default option values are time-varying covariates calculated with prevailing mortgage rate and NACREIF commercial property index using similar method as in Deng, Quigley and Van Order (2000).
18. State unemployment rate is a time-varying covariate measured at the time when the loan is either terminated by prepayment or default or censored.
19. For property type, retail is used as the reference group. Other property type includes Hotel, Manufactured Housing, Self Storage and Healthcare.
20. For regional effect, loans with missing information on region are in the reference group.