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The Termination of Mortgage Contracts through Prepayment and Default in the Commercial Mortgage Markets

BY: Brian A. Ciochetti, Yongheng Deng, Bin Gao and Rui Yao

A better understanding of commercial mortgage termination through default or prepayment has important practical implications. With their relatively simple financial structure ¾ one underlying property and one collateralized debt obligation ¾ commercial mortgages provide an ideal economic setting to test the rationality of investors and the empirical applicability of contingent claim models. For practitioners, the identification of factors relating to default and/or prepayment helps efficiently determine not only the appropriate spreads in the underwriting of whole loans, but also diversification strategies affecting pools of loans by such categories as property type and geographic location. For fixed income investors, an appropriately specified empirical termination model can provide a structured methodology to incorporate contemporaneous information in the valuation of not only whole commercial loans, but also their securitized counterparts. Moreover, such a model provides a basis for regulators to set standards efficiently in risk-based minimum capital requirements for both life insurance companies and commercial banks.

In this study, we adopt a competing risk model developed by Deng, Quigley, and Van Order [2000], because default and prepayment clearly are competing risks: the borrower forfeits one option by exercising the other. This approach represents a departure from previous studies, which ignore the impact of the prepayment option on the default decision; they do so on the grounds that many loans include some form of lockout, or yield maintenance provision to discourage prepayment. Yet these forms of contracting were not widespread in the commercial mortgage markets until the mid-1980s; furthermore, even since then, prepayment is found to occur frequently, resulting in pricing fluctuations larger than those associated with default risk (see Fu et al. [2000]).

Characteristics of Commercial Mortgages

Commercial mortgage markets differ from their residential counterparts in several significant respects. Commercial loans finance investment opportunities, and are typically used by sophisticated investors and real estate developers. Thus, borrowers of commercial debt have very low "psychological" attachment to the underlying asset and should, in theory, be more "ruthless" in the exercise of either the default or prepayment option. Loans are typically fixed rate and fixed payment notes without recourse and are either interest-only or amortizing, with a balloon payment prior to the full amortization term. Prepayment is very often discouraged, but not entirely prohibited, via penalties and/or yield maintenance features.

Embedded in each mortgage is a termination option that can be exercised by the borrower through either prepayment (call option) or default (put option). If the borrower chooses to default on scheduled payments for (up to) 90 days, the lender faces two choices: (1) foreclosure and directly owning the property, and (2) renegotiating the debt contract, often deferring or accepting less than full payment.

After the mass prepayment wave in the late 1970s and early 1980s, banks and life insurance companies included various covenants in mortgage contracts, such as lockout periods, prepayment penalties, and yield maintenance provisions, to reduce the incentives to prepay and thereby to

stabilize expected cash flows The covenant most likely to eliminate incentives for a borrower to prepay is—at least in theory—the yield maintenance provision, under which the borrower is required to pay the full difference between the accounting mortgage balance and the market value of the mortgage.

Sources of Data

Loan level data come from a large, multi-line life insurance company and consist of 2,589 individual loans originated from 1974 through 1990. Relevant loan level characteristics include loan size, contract interest rate, loan term, quarterly status indicator, contractual payment information, borrower type, property type collateralizing the loan, and geographic location. Property value and cash flow indices come from the National Council of Real Estate Investment Fiduciaries (NCREIF), and data from the American Council of Life Insurance (ACLI) serves as a proxy for prevailing commercial mortgage interest rates. We match 2,090 individual loans with the NCREIF series. ACLI commitment rate data provide an estimate of the contemporaneous market value of each mortgage from the borrower's perspective.

Estimation Results

Borrowers with large intrinsic values of the put (LTV RATIO) or call option (CAL RATIO) are more likely to default or prepay (see Figures 1 and 2). Furthermore, the effects of the intrinsic value of options on instantaneous prepayment and default hazards are convex. Prepayment is not sensitive to the intrinsic call value when it is out-of-the-money, yet starts to increase very rapidly after CAL RATIO becomes positive until it hits about 30 percent (see Figure 2). Mortgage default, however, begins to increase before the point of negative equity (Figure 1). This may in part reflect noise in our measurement of property value as compared to our measurement of the call value. We also find call (put) risks strongly affect the exercise of put (call) option. Very large values of the put option (high LTV RATIO) reduce the likelihood of prepayment, while high values of the call option (high positive CAL RATIO) moderate the risk of default. These indirect effects confirm the significance of the *jointness* of the two mortgage options and the importance of modeling them as competing risks ¾ by exercising the call (put) option, the borrower forfeits both the future default and prepayment options. The effect of contemporaneous LTV on prepayment risk may be explained by institutional constraints on required equity levels necessary for borrowing. Highly negative CAL RATIO (deeply out-of-the-money), however, is found to reduce the default hazard risk (see Figure 2). We believe this result captures the large number of low interest loans made in the mid- to late 1970s that were subsequently paid off by borrowers per the terms of the mortgage contract in the high interest rate environment of the early 1980s, before the general implementation of sophisticated prepayment penalties.

We find that *contemporaneous* insolvency, proxied by a low debt coverage ratio (DCR), significantly raises default risk while reducing prepayment risk, even *after* controlling for the value of the put and call options. The significance of cash flow variables on default suggests that borrowers with negative equity do not default as long as income generated by the property is sufficient to cover scheduled debt payments. An alternative explanation is that borrowers in cash flow distress might default with positive equity in their property. This seems to imply that the costs for selling or for additional short-term equity financing are very high, rendering them more expensive alternatives to default. Contrary to prior research, DCR at *origination* shows up negative in the hazard function for prepayment and insignificant for default hazard. Borrowers may

Figure 1. The Effect of LTV Ratio on Prepayment and Default Hazard

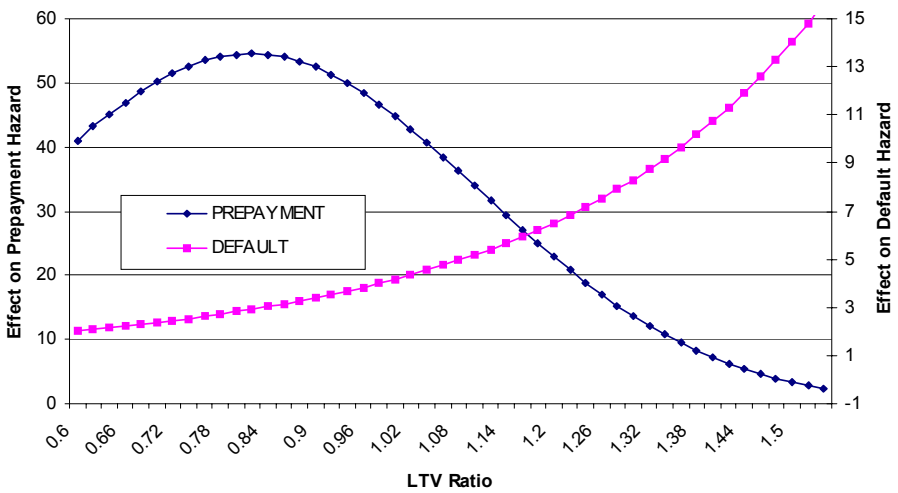
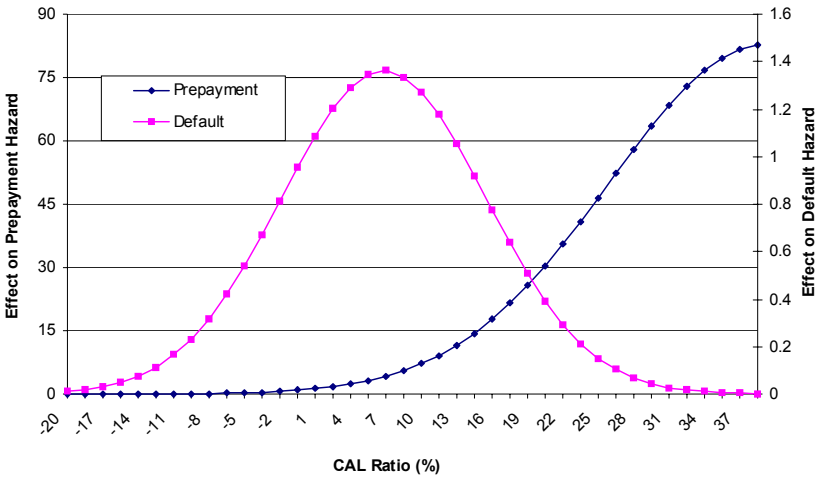


Figure 2. Effect of Call Ratio on Prepayment and Default Hazard



engage in "window dressing" their cash flow projections, much as corporations may do before raising capital through debt or equity. Thus, short-term earnings projections may not be sustainable, with the mean eventually reverting to the index average. Moreover, this finding emphasizes the importance of estimating *contemporaneous* variables when specifying models of mortgage prepayment and default.

Borrowers of large loans are found to be more likely to default but less likely to prepay, while borrowers of smaller loans are more likely to prepay. Loan size can capture differences in costs of capital and bargaining power in workout situations, which shifts the optimal exercise boundary of the options. Borrowers of smaller loans are usually charged higher coupon rates initially. Yet, as these borrowers gain more expertise in property management and accumulate more experience, they can obtain better financing arrangements. Lacking alternatives for low-cost borrowing, borrowers of small loans might also resort to refinancing or selling in order to cash out equity for personal consumption and/or business expansion. Borrowers of large loans may have fewer incentives to protect their credit from default, possibly because of their well-established credit history, experience in property management, or ownership structure. They are also more likely to exert influence in the ex post negotiation with the lender, since they can best manage the underlying property securing the mortgage. Borrower type does not seem to affect either default or prepayment risks. Loan size dummies appear better at capturing the variation in borrowers' bargaining power and credit availability than are borrower type dummies.

Property type does not seem to affect default or prepayment risk. The insignificance of property type on default contrasts with the findings of Vandell et al. [1993], where more aggregate indices are employed to construct property value in order to measure solvency conditions. Our findings suggest that the property variables used in their study may capture the residual property-type specific disparity in property value and cash flow conditions.

We find that accrual and step-rate loans are positively related to default risk, reflecting the increasing costs associated with keeping the mortgage option alive as time goes by. These variables may also reflect self-selection at loan initiation. Under asymmetric information, borrowers with higher default risk will choose loans with lower initial payments. As loan balances increase after origination, borrowers of accrual and step rate loans are much more likely to default and less likely to prepay.

The balloon year dummy exhibits a strong impact on both prepayment and default events. Prepayment immediately before maturity reflects the borrower's risk aversion, but has only a small effect on lender's return. Default at balloon year, however, reflects the value of the "wait-to-default" option for the borrower, and the resulting losses to the lender can be severe.[1]

Our estimation shows no significant heterogeneity among borrowers in the risk of exercising call and put options. This result supports the assumption of rational behavior by mortgage borrowers in the exercise of call and put options on commercial mortgages and suggests that our model is well specified. This result is in contrast to Deng, Quigley, and Van Order [2000], where significant heterogeneity is found in prepayment but not in default. We postulate that this may result from the low occurrence of default activity relative to prepayment activity in their mortgage data, since 73.6 percent of the loans in their sample are prepaid, while only 1.6 percent default. In the present study, we observe 28.8 percent prepayment and 27 percent default activity, respectively.

Conclusions and Implications

This study is the first to examine commercial mortgage default and prepayment in a competing risk hazard framework using loan level data. We explicitly model prepayment and default as a joint mortgage termination option. Our empirical findings are largely consistent with the predictions from the theory of contingent claims and prior empirical research using residential mortgage data. High values of put and call options greatly increase the default and prepayment risk in a nonlinear (convex) manner. The value of the put/call option is also found to significantly affect the exercise of the call/put option, thus capturing the competing-risk nature of the two termination events.

We also show that option pricing theory alone is not adequate to explain commercial mortgage defaults and prepayments. The financial sophistication, bargaining power, solvency, and credit history of borrowers also affect the mortgage termination decision by shifting the exercise boundary of both the prepayment and default options.

Relative to research conducted on residential mortgages, we find no evidence of unobserved heterogeneity among mortgage borrowers under a strict definition of mortgage default. However, we do find weak evidence of unobserved heterogeneity under more general definitions of mortgage default. On further examination, heterogeneous behavior of mortgage borrowers comes mainly from exercise of the prepayment option, which is consistent with conclusions from residential studies.

Relative to research conducted on commercial mortgages, this study confirms the importance of using contemporaneous information as proxies for the theoretic put and call variables. Interestingly, after controlling for contemporaneous debt coverage ratio, we find no evidence to suggest that the *original* debt coverage ratio is related to commercial mortgage default. This contrasts with prior work, which fails to include contemporaneous cash flow information in the empirical model specification.

Our results have important practical implications. We establish empirically that aggregate indices contain valuable information about the performance of individual loans and demonstrate how to incorporate such information efficiently through a hazard model framework. Future default and prepayment paths can be predicted by simulating property value and interest rate processes to allow for the pricing of whole loans and their securitized counterpart. The competing risks methodology is also applicable to regulators in order to set efficient minimum capital requirement for institutions involved in commercial mortgage lending. As exogenous observable variables shift the option's exercise boundary and affect mortgage terminations through the transaction cost structure, they should be explicitly considered in both the underwriting and the pricing of commercial mortgages. These important issues warrant continued research.

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(Footnotes)

[1] See for example Snyderman [1994], Ciochetti and Riddiough [1998], or Ciochetti and Shilling [1999].