Asymmetric information, adverse selection, and the pricing of CMBS[†]

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Abstract

We demonstrate that asymmetric information between sellers (lenders) and buyers (securities issuers and investors) of commercial mortgages gives rise to a standard "lemons problem", whereby portfolio lenders use private information to liquidate lower quality loans in CMBS markets. Conduit lenders, who originate loans for direct sale into securitization markets, mitigate problems of asymmetric information and adverse selection in loan sales. Our theory provides an explanation of the pricing puzzle we observe in the CMBS market, whereby conduit CMBS loans are priced higher than portfolio loans, even though commonly accepted wisdom suggests they may have been originated at lower quality. Consistent with the existence of a "lemons discount", our empirical analysis of 141 CMBS deals and 16,760 CMBS loans shows that upon controlling for observable determinants of loan pricing, conduit loans enjoyed a 34 bps pricing advantage over portfolio loans in the CMBS market.

JEL Classification*:* G14, G12, D82

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1. Introduction

In the wake of ongoing disruption to the real estate capital markets, analysts and policymakers alike have sought to better understand the collapse of mortgage derivatives. Much attention has been paid to the abuses to securitization, notably including those associated with security design, excess leverage, opaqueness, and lax ratings. Analysts similarly have argued that "conduit lending", a process whereby mortgage lenders originated loans expressly for pass-through to securitization markets, was conspicuous among deconstructing forces. Specifically, critics claim that pass-through of loans to securitization markets damped originator incentives to appropriately screen loans. Those concerns have been cited among flaws of the "originate-to-distribute" business model (see, e.g., Bernanke, 2008; Mishkin, 2008; European Central Bank, 2008; Ashcraft and Schuermann, 2008; Keys, et al, 2008; and Purnanandam, 2009).

While conduit lenders may have contributed to moral hazard in primary market loan origination, those same entities likely mitigated problems of asymmetric information and adverse selection in secondary market loan sales. Unlike portfolio lenders, conduit lenders have limited opportunity and incentive to develop private information on loan quality. Accordingly, conduits may have alleviated a "lemons problem" associated with selection of loans for sale in securitization markets by portfolio lenders. In this manner, conduit lending may have enhanced allocative efficiency in the secondary mortgage market. In this paper, we investigate this hypothesis, via modeling and empirical evaluation of the pricing of conduit- and portfolio-backed commercial mortgage backed securities (CMBS) and loans.

To demonstrate the "lemons problem", and more importantly to derive testable predictions about how the "lemons effect" varies with such parameters as the dispersion of loan quality and the cost of holding loans in portfolio, we first present a simple information economics model of loan sales in securitization markets. In our model, portfolio lenders face the "sell or hold" decision and possess private information about loan quality. Portfolio lender private information derives from their due diligence in loan underwriting and their experience in holding and servicing the loan. This private information may include "soft" information as described in Stein (2002). In selecting loans to sell into securitization markets, portfolio lenders utilize their private information and adopt a strategy of liquidating lower quality loans. Our theoretical results show that, in equilibrium, only lower quality portfolio loans ("lemons") are sold into the secondary markets and that their selling price incorporates a "lemons discount". In contrast, conduit lenders originate loans exclusively for direct sale into the secondary market. Conduits lack the incentive to develop "soft" information about loan quality as their profit derives mainly from loan origination fees rather than long-term returns associated with portfolio holding of loans.[1] Further, conduit lenders have little opportunity to develop private information about loan quality post-origination as they generally sell loans into secondary markets shortly after origination. In our model, information is symmetric between seller and buyer in conduit loans sales, all conduit loans are sold into secondary markets, and loan price does not reflect a "lemons discount". Theoretical results also suggest that the magnitude of the "lemons discount" associated with portfolio loan sales varies positively with the dispersion of quality in the mortgage pool and inversely with the seller's cost of holding loans in portfolio. The total surplus associated with the trade is higher in the case of conduit loan sales.

Our model helps to explain a puzzle in the pricing of CMBS loans. As seen in table 1, over the course of the 1994-2000 sample period, CMBS investors paid higher prices for CMBS backed by conduit loans, as evidenced in the substantially lower spreads over Treasuries at issuance among conduit CMBS deals relative to portfolio CMBS deals. According to our theory, the discount on portfolio loans is due in part to the higher residual risk of portfolio loans sold into CMBS markets.

The theory is also consistent with growth over time in the prevalence of conduit loans in CMBS deals. In the aftermath of the advent of commercial mortgage securitization in the early 1990s, loans backing CMBS were largely contributed by

[1] As in Stein (2002), "soft" information cannot be credibly transmitted to a third party. As such, conduit lenders lack the incentive to collect "soft" information.

thrifts and life insurance companies, who originally intended to retain those loans in portfolio. However, in the wake of CMBS market growth, conduit lending emerged whereby originators funded mortgages with the express intent of direct sale into securitization markets. Conduit lending constituted less than 5 percent of all CMBS loans in 1992. However, the share of conduit loans grew to 75 percent by 1998 and reached almost 100 percent by 2001. The decline in portfolio loan sales is suggestive of efficiency problems associated with the securitization of those mortgages.

In our empirical analysis, we test theoretical predictions. To do so, we first study the pricing of 141 CMBS deals brought to market during the 1994 - 2000 period. Estimates of a reduced-form pricing model conform to theory. Results indicate that portfolio-backed CMBS deals were priced 33 bps lower than conduit deals, after controlling for observable CMBS pool characteristics and other well-established determinants of CMBS pricing, including slope of the Treasury yield curve, interest rate volatility, the Sharpe ratio, corporate bond credit spreads, and CMBS market capitalization.

We further assess the robustness of the CMBS deal-level results via a loan-level analysis of commercial mortgage loan pricing. Here our sample includes 13,655 conduit loans and 3,105 portfolio loans sold into securitization markets during the 1994-2000 period. Our findings indicate a pricing differential of 34 bps after controlling for observable credit quality and other well-established loan pricing determinants, including loan-to-value ratio (LTV), amortization term, collateral property type, property location, prepayment constraints, characteristics of the affiliated CMBS pool, CMBS market cap, and the like. Moreover, we find that the "lemons discount" is lower for multifamily loans, which are characterized by lower levels of uncertainty and lender private information than retail, office and industrial loans. This is consistent with theoretical predictions that buyers are more reluctant to trade and the "lemons discount" is larger when information asymmetry is more severe. Overall, results of both the deal-level and the loan-level analyses are highly supportive of our theoretical predictions.

Our intuition for our paper derives from a simple application of Akerlof's "market for lemons" theory to financial markets. It is noteworthy that substantial theoretical research has sought to address information asymmetry and adverse selection problems in financial markets (see, e.g., Leland and Pyle, 1977; Riley, 1979; Stiglitz and Weiss, 1981; Myers and Majluf, 1984; John and Williams, 1985; Diamond, 1993; Winton, 1995; DeMarzo and Duffie, 1999; and DeMarzo, 2005). However, empirical evidence of such effects is limited. This paper, by way of application to the market for CMBS, presents empirical evidence of the "lemons effect".

Our empirical findings are consistent with a recent study by Downing, Jaffee, and Wallace (2009), who show that residential mortgage-backed securities (RMBS) sold by Freddie Mac to bankruptcy remote special purpose securitization vehicles (SPVs) were characterized by lower credit quality than those retained by Freddie in portfolio. The authors argue that their findings are consistent with the notion that Freddie Mac used private information to deliver "lemons" to securitization markets.

Empirical results of our paper also largely confirm findings evidenced in the broader empirical literature on mortgage and bond pricing (see, e.g., Rothberg, Nothaft, and Gabriel, 1989; Fama and French, 1989; Rothberg, Blume, Keim, and Patel, 1991; Bradley, Gabriel, and Wohar, 1995; Collin-Dufresne, Goldstein, and Martin, 2001; Titman, Tompaidis, and Tsyplakov, 2004; Longstaff, Mithal, and Neis, 2005; and Titman and Tsyplakov, 2010). For example, our findings suggest that CMBS market cap, slope of the Treasury yield curve, amortization term, prepayment constraints, and mortgage pool diversification all negatively impact commercial mortgage spreads, whereas the corporate bond spread, CMBS loan maturity, and share of hotel loans in the CMBS pool are all positively related to spreads. In addition, we find that the lagged risk-adjusted return in commercial property markets has a strong negative impact on CMBS spreads.

The paper proceeds as follows: the next section briefly describes the rise of conduit lending and provides background of our study. Section 3 presents our information economics model whereas section 4 discusses our empirical modeling and results. Concluding remarks are provided in section 5.

2. Commercial mortgage securitization and conduit lending

Commercial mortgage debt markets recorded substantial growth over the course of recent decades. By early 2008, commercial mortgage debt outstanding (inclusive of multifamily loans) reached $3.38 trillion, up from $500 billion a decade earlier. Of that number, about $0.92 trillion were held by CMBS issuers.[2]

Prior to the advent of securitization markets, commercial mortgage lenders, including banks and thrifts, life insurance companies, and pension funds, originated commercial mortgages with the intention of holding those loans in portfolio. In 1984, Solomon Brothers originated $970 million mortgages on three office buildings and offered securities to the public based on the projected mortgage cash flows. Later, in the wake of the severe real estate downturn of the early 1990s, the Resolution Trust Corporation (RTC), sought to liquidate the commercial mortgage loan portfolios of failed thrifts via large-scale securitization.

Securitization is the process whereby debt assets are pooled, packaged and derivative securities issued against those assets. For example, an investment bank might purchase commercial mortgages from loan originators, place those loans in a trust and then issue CMBS against the trust. Those securities, representing claims on the cash flows generated by the underlying commercial mortgage assets, would then be sold to investors. Issuance of CMBS grew rapidly from $2 billion in 1989 to some $630 billion in 2006, before falling back to less than $100 billion in 2008.

In the wake of the advent of securitization markets, loans backing CMBS issues derived largely from the "held for investment" asset portfolios of financial institutions and life insurance companies. Those originators sold their loans to CMBS issuers either to liquidate nonperforming loans or to remove performing loans from

[2] See Commercial Mortgage Securities Association, Compendium of Statistics, June 26, 2008.

their balance sheet, so as to reduce capital reserve requirements or to allow investment in other assets.[3]

As commercial mortgage securitization became prevalent, conduit lending, emerged as an important market completing element of the commercial mortgage market. In this case, the originator, usually an investment bank or a mortgage bank, originated commercial mortgages with the express intent of directly selling those loans into secondary markets. The conduit lender usually passed the originated loans through to security issuers upon loan origination and thus simply acted as a "conduit".[4] In this case, it was not the lender, but rather investors on Wall Street, who funded the commercial mortgages. The lender/originator profited mainly via loan origination fees rather than from longer-term portfolio investment in the asset.

A priori, one would expect portfolio as well as conduit lenders to avail themselves to liquidity provided by CMBS markets. Indeed, after controlling for credit quality and anticipated performance, there should be no reason to observe a price differential between portfolio and conduit commercial real estate loans in securitization markets. Below, we develop an information economics model to demonstrate why conduit CMBS loans were priced higher than portfolio CMBS loans and why conduit lending became the preferred source of CMBS loans.

3. A "market for lemons" model

In this section, we present a simple information economics model to examine commercial mortgage and CMBS loan pricing. In that regard, assume there are n loans in a commercial mortgage pool and each loan is characterized by the pair

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[3]As discussed below, regulators require lower levels of capital reserves for more liquid mortgage-backed securities relative to idiosyncratic and less liquid whole loans. Note also that the RTC asset pools labeled "N-Series" and "S-Series" largely consisted of non-performing and sub-performing loans originally held in thrifts' and banks' portfolios. In contrast, the $1.3 billion securitization of Canadian Confederation Life Insurance's portfolio of U.S. commercial mortgages in 1995 was comprised of performing assets and for other business purposes.

[4] In some cases, a short period of warehousing may be necessary in order for conduit lenders to accumulate a pool for securitization.

$\{c_i, X_i\}$, $i = 1, 2, ..., n$, where c_i is a vector of loan contract characteristics such as loan balance, loan term, interest rate, etc., and X_i is the (observable and unobservable) risk of the loan.[5] We denote the nonnegative final payoff of loan i in the marketplace as Y_i, which is determined by c_i and X_i, i.e. $Y_i = f(c_i, X_i)$. For notational convenience, we normalize the market interest rate to zero, and thus in absence of capital market imperfections, the market value of the loan is $E(Y_i)$.

If market participants (including lenders and security issuers) had perfect information on the risk of each loan X_i and applied full risk-based pricing, lenders would choose a corresponding set of loan origination terms c_i so as to result in the same expected payoff (value or yield) for all the loans. However, in the marketplace, mortgage loans may have different expected payoffs. In recognition of such, we decompose Y_i into three components: $Y_i = u + V_i + Z_i$, where u corresponds to the value of the loan adjusted for observable risk characteristics associated with loan underwriting terms; V_i reflects unobservables not accounted for in loan terms; and Z_i represents random shocks to loan payoff.[6] For example, V_i might include lender private information about loan risk developed during the underwriting process or during the loan holding period that is not reflected in loan underwriting documents.[7] Let $Y \equiv \{Y_1, Y_2, \cdots, Y_n\}$ denote the vector of payoffs for n loans in the mortgage pool, and similarly for V and Z; we assume $E(Z_i \mid V) = 0$. For convenience, we further

[5] The signature risk of commercial mortgage is default risk. There may also be prepayment risk depending on the extent to which prepayment is restricted or compensated in the mortgage contract.

[6] The term u represents loan valuation in a world of perfect information. Hence no subscript i is attached.

[7] For example, since lenders work closely with borrowers, they may possess borrower or firm specific information that is not reported in the loan underwriting documents. This information is similar to firms' "soft" information about investment projects as described in Stein (2002).

assume that V_i is uniformly distributed, i.e. $V_i \sim U\left[\underline{v}, \overline{v}\right]$[8], and thus $u+\underline{v}$ and $u+\overline{v}$ represent the worst and the best expected payoffs (loan quality), respectively, in the mortgage pool.

We study loan sales in the secondary mortgage market. Here the mortgage originator (lender) is the seller of the loan and the security issuer/investor is the buyer. We assume all agents are risk-neutral. For the payoff $Y_i = u + V_i + Z_i$, in case of portfolio loan sales, we assume the seller knows exactly the value of V_i while the buyer knows only the distribution of V_i. As suggested above, the seller's superior information comes from two channels, including due diligence in underwriting and experience in holding the loan prior to sale in the secondary market. Note that the dispersion of V_i is a measure of the severity of information asymmetry present in the trade.

In the case of conduit loan sales, we assume both the seller and the buyer in the secondary market know only the distribution of V_i. This symmetric information assumption reflects the nature of conduit lending operations. As discussed above, conduits originate loans for the purpose of direct securitization. Conduit lenders are compensated largely on the basis of origination fees; further, they generally pass through loans to the purchaser upon origination. Conduit lenders have neither the opportunity nor the incentive to develop private information on loan risk.

Owing to regulatory requirements, lenders face costs of holding loans in portfolio, including those associated with mandated capital reserves and deposit insurance if the loan is funded with deposits. Further relevant to our analysis here, note that added capital reserves are required for holding whole loans in portfolio, given their limited liquidity, relative to reserves required for holding more liquid mortgage-backed securities, Treasury bonds and cash (Calem and LaCour-Little 2004). Accordingly, in our model, we identify the above reserve-related costs as

[8] The uniform distribution is just for mathematical simplicity. However, the analysis can be readily extended to other distributions with no substantive change in our findings.

"incremental" to the loan seller. In contrast, the loan buyer faces lower reserve-related holding costs associated with securitized loans. We express this incremental cost as a percentage of the loan value, δ. In other words, lenders have lower valuations (by $1-\delta$) than secondary market investors of loans offered for sale in securitization markets.

As regards secondary market structure, note that the commercial mortgage market is characterized by numerous loan originators (who sell loans in the secondary market) but only by a handful of security issuers and institutional investors (who purchase commercial mortgages).[9] Accordingly, we assume that loan buyers possess market power in the secondary market for commercial mortgage loans.[10]

3.1 Pricing of portfolio loans

Portfolio lenders originate commercial mortgage loans with intent to hold those loans in their investment portfolios. However, for reasons discussed in section 2, portfolio lenders may subsequently decide to offer some loans for sale in the secondary market. As described above, portfolio lenders possess superior information about the quality of loans they seek to sell. However, the mortgage purchaser (institutional investor) has pricing power. Accordingly, the seller faces a "take it or leave it" decision based on his private information about loan value, i.e. a trade happens iff $p \geq E\left[(1-\delta)Y_i \mid V_i\right]$.[11] As a result, the probability of a loan (or share of a loan pool) being sold, $q \in [0,1]$, will depend on the buyer's bid, i.e. $q = q(p)$. The buyer will choose an optimal bid to maximize his expected profit from the trade. The buyer's profit function can then be expressed as:

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[9] In the residential mortgage market, Fannie Mae and Freddie Mac are the duopolistic security issuers. In commercial mortgage market, the few big investment banks are the major security issuers.

[10] While this assumption coincides with our understanding of the institutional structure of CMBS market, we refer readers to DeMarzo and Duffie (1999) and DeMarzo (2005) for the situation in which the seller has both an information advantage and monopolist power. They address the alternative situation with a signaling game under a slightly different setting.

[11] The buyer will bid a uniform price for the whole mortgage pool given that he cannot distinguish good loans from bad loans. Therefore, there is no subscript in p.

$$\max_{p}\left\{\left[\sum_{\underline{v}}^{v[q(p)]} E\left(Y_i \mid V_i\right)-n\cdot q\left(p\right)\cdot p\right]+n\cdot\left[1-q\left(p\right)\right]\cdot 0\right\}. \tag{1}$$

In equation (1), the first $[\cdot]$ represents those loans traded – the buyer pays $n\cdot q\left(p\right)\cdot p$ for loans worth of $\sum_{\underline{v}}^{v[q(p)]} E\left(Y_i \mid V_i\right)$, which represents the summation of the values of loans ranging from that with the worst quality ($V_i = \underline{v}$) to that loan of a certain quality limit ($V_i = v\left[q\left(p\right)\right]$). This outcome reflects adverse selection in trading: the buyer knows that the seller possesses superior information about loan quality and will offer only the worst quality loans ("lemons") for sale at any given buyer bid p. Accordingly, the buyer accounts for asymmetric information and adverse selection in formulating his bid. The second part in the profit function simply says that if a trade does not happen, the buyer will get zero profit.

Given our distributional assumptions regarding V_i and $\delta \ll .5$, we can solve the above problem and offer the following proposition:[12]

Proposition 1: In portfolio loan sales, the uninformed buyer will bid a price lower than his valuation but higher than the seller's reservation price. In this case, only a fraction of the mortgage pool representing lower quality mortgage loans will be traded. The bid price is

$$p^{*}=\frac{(1-\delta)^{2}}{1-2\delta}\left(u+\underline{v}\right), \tag{2}$$

and the share of loans traded is

$$q^{*}=\frac{\delta}{1-2\delta}\frac{u+\underline{v}}{\overline{v}-\underline{v}}. \tag{3}$$

Proof: see Appendix.

[12] The real world incremental holding cost is often estimated at about 1 to 4 percent of the loan balance.

For the share of loans traded, the buyer's valuation is $\bar{p} = \frac{2-3\delta}{2(1-2\delta)}(u+\underline{v})$ whereas the seller's valuation (reservation price) is $p^s = (1-\delta)\bar{p}$.

The above situation is typical to a "market for lemons" as described by Akerlof (1970). However, from our formulation, it is apparent that the higher the seller's incremental holding cost, the more likely it is that the seller will liquidate loans in his portfolio as $\frac{\partial q^*}{\partial \delta} > 0$. Further, the more severe the information asymmetry between the buyer and seller of loans, the more reluctant will be the buyer to trade as $\frac{\partial q^*}{\partial \phi} < 0$, where $\phi = \bar{v} - \underline{v}$ measures the extent of information asymmetry between the seller and the buyer. Note that the sales price is higher than the seller's reservation price, which means the seller will profit from the sale. This is consistent with the intuition that the informed seller can extract information rents from trade. However, given the buyer's monopsonistic power, the sales price is also lower than the buyer's valuation, which means the buyer can also profit from the trade.

In figure 1, we characterize the above situation.

3.2 Pricing of conduit loans

As discussed previously, conduit lenders originate loans for pass through and sale in securitization markets. Since there is no information asymmetry (both the seller and the buyer know only the distribution of V_i but not its precise value), neither party can distinguish good loans from bad loans. Therefore, the buyer's profit function maximization becomes

$$\max_p \left\{ n \cdot q(p) \cdot \left[E(Y_i) - p \right] + n \cdot \left[1 - q(p) \right] \cdot 0 \right\}. \quad (4)$$

In theory, conduit lenders also face incremental holding costs prior to sale of loans into the secondary market. Accordingly, the conduit lender's reservation price is $(1-\delta)E(Y_i)$. Note that for any bid price p higher than the reservation price, the seller's response will be to take a random draw from the pool of loans for sale to form the quantity q for trading since he cannot distinguish good loans from bad loans. This is reflected in buyer's valuation of the loans traded, $n \cdot q(p) \cdot E(Y_i)$.

The following proposition summarizes the solution of the aforementioned problem:

Proposition 2: All conduit loans are sold and the selling price is

$$p^* = (1-\delta)\frac{2u+\bar{v}+\underline{v}}{2}. \tag{5}$$

Proof: For each loan, the buyer's valuation is $\bar{p} = \frac{2u+\bar{v}+\underline{v}}{2}$ and the seller's reservation price is $p^s = (1-\delta)\bar{p}$. The buyer will simply bid the price down to the seller's reservation price to extract the full surplus and to make the seller indifferent to selling all originated loans.[13]

Figure 2 depicts the above situations.

3.3 Comparing portfolio and conduit loans in the CMBS market: the market for lemons

From the above discussion, it is evident that information asymmetry results in a "lemons effect" in the sales and pricing of portfolio loans in the CMBS market. In this section, we seek to quantify the magnitudes of those loan sales and pricing effects. Recall, per above, that V_i represents residual lending risk not captured by commonly known underwriting factors. For sake of comparison, we assume here that the V_i for portfolio and conduit loans follow the same distribution.

In that case, the traded share of originated loans is smaller for portfolio loans as only the low quality loans are traded. In contrast, all originated conduit loans are traded in the secondary market. To illustrate, we pick reasonable model parameters and compute the portfolio and conduit traded shares based on results in proposition 1.

[13] Notice that the conduit loan sellers usually profit from loan origination fees.

Assume that the incremental cost of holding whole loans is 3 percent of the loan balance (δ =3%) and that among the loan origination pool, the best and worst quality loans have a yield differential of 148 bps (as indicated by private information available to the portfolio lender), i.e., $\underline{v}$= -7%u, $\bar{v}$= 7%u and thus ϕ= 14%u). In this case, model results indicate that only the lower 21 percent of portfolio loans in the pool are traded. The share of portfolio loans traded increases with portfolio incremental holding costs. Figure 3 shows this relation, which is consistent with the comparative statics $\frac{\partial q^*}{\partial \delta} > 0$ in section 3.1. In addition, the share decreases with respect to the quality dispersion of loans in the origination pool, as loan quality dispersion increases the severity of the information asymmetry and the related reluctance of information-disadvantaged buyers to buy. This relation is reflected in figure 4.

Second, we compare the price of portfolio and conduit loans sold into the CMBS market. According to our analysis in sections 3.1 and 3.2, portfolio and conduit loan pools in the CMBS market are characterized by an equivalent term u, which is the expected payoff corresponding to observable loan risk characteristics. However, given unobservable information on loan quality, V_i, portfolio loans traded only represent the lower spectrum of the distribution ("lemons") and thus the price of portfolio loans reflects the "lemons discount". We offer the following proposition:

Proposition 3: The price of portfolio loans is generally lower than that of conduit loans in the CMBS market due to the "lemons discount".[14] The discount is

$$l = \frac{2(1-\delta)(u+\underline{v})}{(1-2\delta)\left(2u+\bar{v}+\underline{v}\right)}. \qquad (6)$$

Proof: The lemon's discount l is the ratio of the portfolio loan price in equation (2) to the conduit loan price in equation (5).

[14] With a condition $\bar{v} - \underline{v} > 2\delta u$, which is generally true in real world.

It is then straightforward to compute the comparative statics $\frac{\partial l}{\partial \delta} < 0$ and $\frac{\partial l}{\partial \phi} > 0$

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Again we pick some reasonable model parameters and compute the "lemon's discount" based on the above results.

When the incremental holding cost is 3 percent and loan quality dispersion is 148 bps ($\underline{v}$= -7%u, $\bar{v}$= 7%u), the lemon's discount is about 44 bps. The lemon's discount decreases with respect to the seller's incremental holding cost and increases with respect to the dispersion of loan quality, as shown in figures 5 and 6.

Finally, we consider the total surplus associated with the portfolio and conduit loan sales. Regardless of whether a portfolio or conduit loan sale, the total surplus for each loan sold is $\delta E\left(Y_i\right) = \delta\left(u + V_i\right)$. Based on our aforementioned results, loans sold in the portfolio case are only the lower spectrum of the loan quality distribution while loans sold in the conduit case are the full spectrum of the loan quality distribution. Therefore, the total surplus associated with the trade is higher in the conduit loan sale case than that in the portfolio loan sale case, suggesting that conduits provided a more efficient mechanism of sale of loans into the secondary market.[15]

4. Empirical analysis

The empirical analysis proceeds from a large dataset (see section 4.2 below) which provides information on both the pricing and underwriting of commercial loans sold into securitization markets. Using this information, the observable risk-adjusted value u can be computed. Note that we do not observe lender private information V_i. Further, we do not observe the portfolio lender's choice of which loans to sell into the secondary market and hence are not able to provide direct evidence as to whether the

[15] As is evident, our analysis focuses on efficiency gains associated with conduit loan sales in securitization markets. As suggested above, problems of "moral hazard" may have been associated with conduit loan originations in the primary market.

portfolio loans traded in CMBS markets comprise the lower spectrum of the distribution of all portfolio loans originated. However, in the spirit of Bond (1982), we are able to analyze loan sales in the CMBS market and test for the "lemons effect". Specifically, we examine the pricing of portfolio and conduit loans and evaluate whether loan pricing is consistent with our theoretical results. Our empirical work includes pool-level and individual-level analyses of yield spread differentials between conduit and portfolio loans.

4.1 Comparing the pricing of portfolio and conduit loans

According to proposition 3, upon controlling for publicly observable loan quality (underwriting) differentials, portfolio loans in CMBS pools should represent the lower spectrum of the V_i distribution and should be priced lower than conduit loans in CMBS pools. This is the "lemons discount" identified in the pricing of portfolio CMBS loans. Below, we specify and control for well-known determinants of commercial mortgage loan pricing, so as to empirically identify the "lemons discount".

4.1.1 Observable loan characteristics that affect the pricing of CMBS loans

Loan-to-value ratio (LTV) and debt-service coverage ratio (DSCR): The debt-to-asset ratio has long been considered an important predictor of corporate default (see, e.g., Altman, 1968; and Frydman, Altman, and Kao, 1985). Similarly, in the real estate literature, considerable evidence suggests that the loan-to-value ratio (LTV) and the debt service coverage ratio (DSCR) of commercial mortgage loans are important predictors of default risk (see, e.g., Episcopos, Pericli, and Hu, 1998; Archer, et al, 2001; Goldberg and Capone, 2002; Ciochetti, et al, 2002; Seslen and Wheaton, 2005; Yildirim, 2008; and An, Deng, and Sanders, 2009). We anticipate that increases in LTV should positively affect spreads on CMBS loans, whereas increases in DSCR should have the opposite effect.

Amortization and maturity term*:* Episcopos, Pericli, and Hu (1998), Ciochetti, et al, (2002) and An (2007) have found that commercial mortgage loans that amortize (or commercial loans with longer amortization terms) have lower default risk than interest only (or shorter amortization term) loans. An (2007) also has found that commercial mortgage loans with longer maturity terms have lower default risk than those with shorter maturity terms. We similarly control for these effects in the pricing of our sampled CMBS loans.

Property type: Existing literature (see, e.g., Vandell, et al, 1993; Ciochetti, et al, 2002; Ambrose and Sanders, 2003; and An, 2007) has shown that commercial mortgage default varies systematically with collateral property type. Typically, multifamily loans are the least risky, followed by retail and office property loans. Industrial and hotel loans are viewed as the most risky of commercial property collateral. Accordingly, we control for collateral property type and anticipate like differentials in the pricing of CMBS loans.

Property location: As would be anticipated, prior research (see, e.g., Follain, Ondrich, and Sinha, 1997; Ambrose and Sanders, 2003; Archer, et al, 2001; Ciochetti, et al, 2002; An, 2007; Yildirim, 2008; and An, Deng, and Sanders, 2009) has provided evidence of substantial geographic variation in commercial mortgage prepayment and default risk. Historically, lower default risk has been evidenced in the Pacific region, whereas loans in East South Central and West South Central have been characterized by elevated default risk. We control for geographic location of loans in the pricing of CMBS loan pools.

Prepayment constraint: The presence of prepayment risk should damp the price of commercial mortgages. As such, any constraint on the borrower's ability to prepay the loan should reduce the lender required prepayment premium. Further, Ambrose and Sanders (2003) and An, Deng, and Sanders (2009) have found that the presence of prepayment constraints also affects the probability of commercial mortgage loan default. The empirical analysis controls for the presence of constraints on mortgage prepayment in sampled CMBS pools.

Diversification: Harding, Sirmans, and Thebpanya (2004) have found that geographic concentration positively affects CMBS bond spread. Moreover, Harding, Sirmans, and Thebpanya (2004), and An, Deng, and Sanders (2008) have found that loan size and geographic diversification are important to rating agencies CMBS subordination structure. As described below, the analysis includes a Herfindahl index of pool loan size and an entropy index of CMBS pool geographic diversification.

4.1.2 Economic and debt market conditions that affect the pricing of CMBS loans

Corporate bond credit spread*:* The corporate bond credit spread (defined as the yield spread between corporate bonds rated Aaa and Baa) is often used to proxy the market price of default risk. Fama and French (1989) find that credit spreads widen when economic conditions are weak. In the mortgage application, we hypothesize that the default option embedded in the mortgage contract should vary directly with economy-wide credit risk. Accordingly, the corporate bond credit spread at CMBS issuance should positively affect CMBS spreads.

Slope of the yield curve: There exists substantial evidence on the role of the term structure in the determination of mortgage bond spreads (see, e.g., Bradley, Gabriel, and Wohar 1995; Ambrose and Sanders 2003; and Titman, Tompaidis, and Tsyplakov, 2005). An increase in the slope of the yield curve suggests some future strengthening in economic activity, a reduced likelihood of put option exercise in the form of loan default, and a lower default premium. An increase in the slope of the yield curve also reduces the likelihood that the mortgage call option will be in the money, so as to reduce prepayment risk and the related call option premium. Accordingly, increases in the slope of the Treasury yield curve should have a negative impact on the CMBS pricing spread.

Interest rate volatility: Mortgage put and call option values increase with interest rate volatility. In fact, in a contingent claims framework, the debt claim has elements similar to a short position on a put and a call option. This prediction is intuitive and well established in the literature: increased interest rate volatility implies increases in the probability that both mortgage put and call option values are in the money. Accordingly, mortgage spreads should increase with volatility.

CMBS market cap: A number of studies have found that pricing of corporate bonds varies inversely with market liquidity (E.g., Longstaff, Mithal, and Neis, 2005; and

Chen, Lesmond, and Wei, 2007). We conjecture that this is also true for commercial mortgage loans. Consistent with the literature on residential mortgage-backed securities, we proxy for liquidity effects in part via an indicator of dollar capitalization of the CMBS market.[16] Indeed, in early stages of CMBS market development in the mid-1990s, investors may have faced significant liquidity constraints. In a similar vein, Black, Garbade, and Silber (1981) and Rothberg, Nothaft, and Gabriel (1989) conclude that the expansion of the Ginnie Mae market during the 1970s and 1980s had a significant damping effect on GNMA/Treasury yield spreads.

Past commercial property market returns: Case and Shiller (1989) and Atteberry and Rutherford (1993) provide empirical evidence that past returns to residential real estate have some predictive power for current returns. Similarly, in markets for commercial real estate, investors may interpret past returns as indicative of future performance. Accordingly, we test the hypothesis that stronger commercial property returns are associated with a contraction in risk spreads on commercial mortgages.

4.1.3 The reduced-form pricing model

Considering the aforementioned CMBS pricing determinants, we estimate the following reduced form pricing model:

$$P_{it} = D_i\alpha + C_i\beta + W_t\gamma + \varepsilon_{it}\,, \qquad (7)$$

where P_{it} is the spread (defined as the net coupon paid to CMBS investors minus the comparable maturity Treasury rate) for the i^{th} commercial mortgage pool sold at time t. W_t is a set of economic and debt market factors that affect market-wide CMBS loan pricing as discussed above. As those terms are typically time-varying, a subscript t is attached. C_i is a vector representing publicly observable CMBS loan characteristics. D_i is an indicator variable that takes on the value of 1 if the loan is conduit and 0 otherwise, and thus is the focus variable of our analysis. All things being equal, we

[16] In the corporate bond literature, liquidity effects often are proxied via bid-ask spreads. Unfortunately information on bid-ask spreads is not available for CMBS.

expect a significant negative coefficient associated with D_i, representing the absence of a "lemons discount" in the pricing of conduit relative to portfolio loans.

4.2 Data

We access an exceptionally rich CMBS and commercial mortgage loan database acquired through CMBS.COM, which is a major data provider on all CMBS issued in US.[17] CMBS.COM provides detailed information on each CMBS transaction at deal, tranche (bond), loan and property levels. For each CMBS deal, we observe the weighted average coupon (WAC) paid to investors. In a typical CMBS deal, a number of CMBS tranches (bonds) are issued with different exposures to default risk, subordination levels, and expected duration, and thus different tranches can carry different coupons (An, Deng, and Sanders, 2008). The average of all the coupons weighted by cutoff balance is the WAC, which reflects the overall price paid by CMBS investors.[18] In addition to pricing information, the CMBS deal-level data includes detailed information including CMBS issuance date, issuer, trustee, and manager of the deal as well as the deal dollar balance, weighted average debt-service coverage ratio (DSCR), weighted average loan-to-value ratio (LTV), weighted average maturity (WAM), and prepayment constraints. Also, the database includes information on the composition of property types, geographies, loan sizes and like information on underlying loans.

The database further permits identification of loan pricing and lending terms on all mortgage loans included in the aforementioned CMBS deals. Accordingly, for each commercial loan included in the CMBS database, our loan-level database includes information on origination date, origination balance, origination loan-to-value ratio (LTV), coupon rate, maturity, amortization term, property location, lender, prepayment constraint, and the like. Further, for each loan, we also observe a net

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17 The company was sold in 2005 to Standard & Poor's and later to Backshop.

18 Sometimes called net WAC to distinguish it from the gross WAC, which is just the weighted average of interest rates of all loans in the deal. The difference between gross WAC and net WAC is what is earned by CMBS issuers, servicers, rating agencies and possibly the loan originators (loan sellers).

coupon rate, which is the coupon paid to CMBS investors recorded in the data. As discussed below, this information is applied in additional loan level assessment of conduit versus portfolio loan pricing.

Data on corporate bond yields and the term structure of interest rates is obtained from the Federal Reserve. That information is used to construct the corporate bond credit spread as well as proxies for the slope of the Treasury yield curve and interest rate volatility. We also obtain data from the Commercial Mortgage Securities Association on CMBS issuance and CMBS debt outstanding (market cap). Finally, we use National Council of Real Estate Investment Fiduciaries data to construct a Sharpe ratio measure of volatility-adjusted excess returns in commercial real estate by property type.

4.3 Results of a CMBS deal level analysis

In the secondary market, pricing usually is reported at the CMBS deal level. Those deals are typically comprised of a large number of individual commercial mortgages; in our dataset, CMBS deals average 149 mortgages. Accordingly, we first conduct a CMBS deal level analysis to investigate whether investors pay higher prices, all things equal, for conduit CMBS loans than for portfolio CMBS loans.

There are a total of 718 CMBS deals in our database, among which 357 are conduit deals and 45 are portfolio deals.[19] For comparison purposes, we focus on conduit and portfolio deals transacted during the 1994 - 2000 period, when both portfolio loans sales and conduit loans sales were active. We exclude year 1998 because no portfolio deals are observed for that year. That leaves the 118 conduit deals and 23 portfolio deals described in table 2. Table 2 shows the distribution by year of conduit and portfolio deals in our sample. As is evident, with the rise in securitization markets during the latter half of the 1990s, the proportion of deals comprised of conduit loans increased over time.

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[19] Other deal types include fusion deals, franchise deals, single borrower deals, large loan deals, and the like.

Table 3 reports descriptive statistics for the CMBS deals. Deal rate spreads, defined as the deal weighted average coupon (WAC) minus comparable maturity Treasury bond rate, range from 66 bps to 509 bps, with an average of 233 bps. On average, the weighted debt-service coverage ratio (DSCR) of the 141 deals is 1.43, with a range from 1.04 to 2.32. About 29% of the loans in the included CMBS deals are multifamily loans, whereas office, retail, and industrial loans comprise 15, 29, and 6 percent of the total, respectively. We compute measures of loan diversification of each deal, including a Herfindahl Index of loan size, the geographic diversification entropy measure, and proportion of the deal comprised of the 5 largest loans.[20] We also calculate the standard deviations of loan-to-value ratio (LTV) and debt-service coverage ratio (DSCR) of all loans in each deal, as reported in the table.

Table 4 reports the generalized least square (GLS) estimates of our reduced form model in equation (7). Log deal balance at CMBS deal cutoff is used as a weight to correct potential heteroskedasticity. In model 1, we only include a conduit dummy, which provides a simple comparison of the spreads of the two groups of deals. In model 2, we add controls for market conditions that may affect CMBS loan pricing. As expected, the CMBS market cap has a significant negative effect on CMBS loan pricing, consistent with the notion that lower liquidity premia are required by investors as the market expands.[21] Similarly as expected, the corporate bond credit spread and the interest rate volatility term are positively related to the CMBS deal spread. The slope of the yield curve enters with a significant negative sign. This result is consistent with findings from Bradley, Gabriel, and Wohar (1989), and Kau and Peters (2005). The lagged commercial real estate Sharpe ratio does not enter the analysis with a significant coefficient. Upon controlling for the observable

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20 The geographic diversification entropy measure is calculated as

$geo\_div = -\sum_{i=1}^{5} s_i \times \log_6 s_i + \left(1-\sum_{i=1}^{5} s_i\right)\times \log_6\left(1-\sum_{i=1}^{5} s_i\right)$, where p_i is the proportion of loans in the top five concentrated states in the deal. The highest value this measure can take on is 1, indicating that geographic diversification is evenly divided among different states.

[21] We also run the regression with annual CMBS issuance instead of CMBS market cap. The results are qualitatively unchanged.

market-wide risk characteristics, conduit deals are associated with a 26 bps lower spread than are portfolio deals.

In model 3, we add CMBS pool characteristics as additional control variables. Variables representing property type compositions are mostly significant and of the expected sign. For example, consistent with the fact that multifamily and anchored retail loans are perceived to be less risky than other loan types, higher shares of multifamily and anchored retail loans are associated with lower required investor spreads. Further, findings indicate that share of hotel loans in the pool serves to boost the CMBS spread, as loans to hotel operators are generally viewed as relatively higher risk. Contrary to expectations, the prepayment constraint has a positive impact on CMBS spreads. This finding is consistent with that of An, Deng, and Sanders (2009) and perhaps reflects the borrower use of default as a means of loan termination in the case where mortgage contract prepayment constraints are binding.[22] As would be expected, the more geographically diversified the pool, the lower the spread required by CMBS investors. Also, our Herfindahl measure of pool concentration by loan size is marginally significant and of the expected positive sign. Finally, upon controls for a large set of market conditions and CMBS pool characteristics, conduit deals are shown to enjoy a 33 bps pricing advantage.

Results of the deal-level regression indicate that investors pay significantly lower prices for portfolio loans than for conduit loans in the CMBS market. In that regard, findings here support our theoretical proposition of a "lemons discount" in the pricing of portfolio loans. That notwithstanding and in order to assess robustness of findings, we below presents results of loan level analysis. Those tests allow more precise controls for loan underwriting and other observable risk characteristics.

4.4 A loan level analysis

In this section, we apply individual loan-level data to assess the effects of conduit lender status on pricing of loans in commercial mortgage-backed securities

[22] Similarly, in the subprime mortgage market, Quercia, Stegman, and Davis (2005) and Rose (2008) find evidence that prepayment penalties increase mortgage foreclosure risk.

markets. We focus on loans to investors in the four major property types, including multifamily, office, retail and industrial properties. Further, we restrict our sample to fixed-rate commercial loans. This leads to an exceptionally rich sample of 16,760 loans originated over the 1994-2000 period and included in the 141 CMBS deals evaluated above.

As reported in table 5, unadjusted spreads to Treasuries on conduit loans (210 bps) were 47 bps lower than those associated with portfolio loans (257 bps). The median, minimum and maximum of spreads were all lower for conduit loans than those for portfolio loans.

Table 6 reports the termination (cutoff) year breakout of conduit and portfolio loans. As would be expected, that distribution is roughly similar to the distribution of CMBS conduit and portfolio deals shown in table 2.

Table 7 provides descriptive statistics on the loan-level sample. As indicated, the average spread of the 16,760 sampled conduit and portfolio loans over the 1994-2000 period was 220 bps. Average LTV was 69 percent, substantially lower than that of residential mortgages. Most of the commercial mortgage loans are balloon loans – about 83 percent of loans had amortization terms of 20-30 years while about 81 percent of loans had maturity terms of less than 10 years. Loans are from 10 regions all across the nation, including Midwest/Eastern, Midwest/Western, Northeast/Mid-Atlantic, Northeast/New England, Southern/Atlantic, Southern/East Coast, Southern/West Coast, Western/Mountain, Western/Northern Pacific and Western/Southern Pacific. About 74 percent of the loans (months) were covered by at least one form of prepayment constraint (lock out, yield maintenance or prepayment penalty). Bank of America was the largest contributor of CMBS loans. Over 14 percent of loans in our sample were originated by Bank of America, either as portfolio loans or as conduit loans. Wachovia, GE Capital, JPMorgan Chase, Lehman Brothers, Wells Fargo, GMAC, Nomura and CITI Group are among the top 10 originators of the commercial mortgage loans in our sample.

We estimate a reduced-form model in the form of equation (7) at the loan level. Our dependent variable is the price paid by investors in the secondary market as represented by the net spread. Our explanatory variables again include the variable of focus, the conduit dummy, and other controls representing market conditions and loan characteristics. Among the loan characteristics, controls for loan-to-value ratio (LTV), amortization term, maturity term, loan (property) location and prepayment constraint were included in the model.[23] An important issue here is that CMBS investors are purchasing claims on the entire CMBS pool, and thus asset correlations and diversification matter. To account for this, we also include the CMBS deal level information in our loan level analysis.

Table 8 reports our estimates. Again, model 1 demonstrates the raw spread differential. For the market conditions variables, the results are largely consistent with those reported in the deal level analysis. For example, we see that the corporate bond credit spread is significant and of the expected signs in all specifications. In contrast to findings reported in the deal-level analysis, however, the 1-quarter lagged commercial real Sharpe ratio is significant and with expected sign in all specifications, suggesting that stronger lagged performance in the commercial property market is associated with lower commercial mortgage spreads. Regarding loan characteristics, as would be expected, findings indicate that property type matters to loan pricing. Compared to multifamily loans, the omitted category, retail, office and industrial loans all have higher spreads. This is consistent with findings reported in Titman, Tompaidis, and Tsyplakov (2005). For the amortization term controls, the omitted group is loans with amortization terms between 20 and 30 years. Relative to the omitted category, loans with shorter amortization terms are apparently priced higher because amortization helps build equity so as to reduce default risk. This is also consistent with aforementioned evidence in Episcopos, Pericli, and Hu (1998), Ciochetti, et al (2002) and An (2007). The omitted category among loan maturity

[23] We use loan-to-value ratio (LTV) instead of debt-service coverage ratio (DSCR) because only a small proportion of our observations contain DSCR close to the CMBS deal cutoff point. For that small sample, we run a correlation analysis and find that LTV and DSCR are highly correlated, which suggests that LTV is good substitute for DSCR. In the robustness checks discussed below, we use the smaller sample to estimate the model using DSCR rather than LTV, so as to test the sensitivity of our results to this data limitation.

controls is loans with maturity of less than 10 years. Interestingly, the longer the maturity terms, the higher the loan is priced. We also see variations with respect to where the property is located. For example, loans in Southern/Atlantic, Midwest/Western and Western/Mountain areas are priced higher than those in the Western/Southern Pacific reference region. Prepayment constraints have significant positive impact on CMBS loan pricing, which is consistent with the common wisdom that investors may require less prepayment premium when there are prepayment protections. Contrary to expectations, loan-to-value ratio (LTV) is shown to negatively affect loan spreads. This could be due to the endogeneity of LTV to commercial mortgage underwriting and pricing. However, further tests reveal the robustness of conduit pricing results to simultaneous equations models of LTV and loan pricing spread.[24] CMBS pool characteristics are shown to be important, as we see from model 4. In that regards, variables including deal weighted debt-service coverage ratio (DSCR), property type composition and loan size diversification are significant and have the expected signs.

Finally, empirical results show a consistently negative and significant effect of our focus variable on commercial mortgage to Treasury spreads across different model specifications. In our most comprehensive specification (model 4), we find that conduit loans enjoyed a 34 bps price advantage over portfolio loans in the CMBS market after controlling for a wide array of loan quality, CMBS deal diversification, liquidity and prepayment characteristics.

A further benefit of a loan-level analysis is that we can analyze the lemons discount by property type. Multifamily mortgage loans are much more homogeneous than retail, office and industrial loans, suggesting that (in accordance to the comparative statics derived from proposition 4 and as depicted in figure 7) the

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[24] In the spread equation, loan-to-value ratio (LTV) enters with a negative sign and the conduit dummy term remains roughly the same. We also investigated potential endogeneity of loan maturity term to the loan pricing spread. Findings as regards the estimation of a simultaneous equations model of loan term and loan pricing spread indicate robustness of the conduit pricing effect. Results of the estimation of these models are available from the authors upon request.

"lemons discount" should be lower among multifamily loans. Table 9 presents the raw difference in conduit-portfolio spreads by property types. In the model, we control for all the aforementioned observable risk factors and add interactions between loan property type and the conduit dummy. Those results are reported in table 10. As expected, results indicate that the multifamily "lemons discount" is the lowest among property types.

4.5 Robustness

In this section we report on results of a number of robustness analyses. Firstly, as described above, we assess whether our results are sensitive to the use of debt-service coverage ratio (DSCR) instead of loan-to-value ratio (LTV) in our regression. As shown in appendix table 2, regression results indicate that research findings are largely robust to the substitution of DSCR for LTV in the regression analysis.

We also allow for the possibility that investors may pay a premium for loans originated by brand name originators or by originators who have a reputation for strict underwriting. Accordingly, we include categorical controls for the top 25 originators in our sample, and the results are reported in appendix table 3. Interestingly, investors pay a substantial premium for loans originated by lenders who had strong reputations in the commercial mortgage market, including GE Capital, JPMorgan Chase, Morgan Stanley, Wells Fargo, Principal Mortgage and Penn Mutual. That notwithstanding, the coefficient of our focus variable remains unchanged.

We further stratify our loan-level sample by property type and re-run the analysis. Results, reported in appendix table 4, are consistent with those reported above in suggesting that the "lemons discount" is the lowest for multifamily loans and the highest for industrial loans

In addition, we run the regressions by year of loan origination to account for potential issuance timing effects not captured by the market conditions variables used in our models. The results are reported in appendix table 5. As shown, those results are consistent with our prior findings.

Finally, note that we tested the robustness of findings to the use of swap rates rather than constant maturity Treasury bond rates as the benchmark to computation of CMBS/commercial mortgage spreads. Findings are largely robust to the use of swap spreads.[25]

Overall, results from both our deal level and loan level analyses strongly support our theoretical findings: consistent with our hypothesis of a portfolio loan "lemons discount", portfolio loans sold into the CMBS market are priced lower than conduit loans. We summarize our regression results in figure 8. There we observe a substantially higher price paid by CMBS investors for conduit CMBS deals (loans); while part of that difference can be explained by variations across deals in observable loan characteristics and debt market conditions, there remain over 30 bps price difference between conduit deals (loans) and portfolio deals (loans). That pricing difference is consistent with our theoretical findings of "lemons effect", whereby portfolio loan lenders utilize private information to sell low quality loans into the CMBS market. CMBS investors take account of the adverse selection problem and accordingly pay lower prices for the portfolio loans.

5. Conclusions

While information asymmetry is a common feature of financial markets, empirical evidence of such effects is limited. This paper presents an information economics model and related empirical evidence of asymmetric information and adverse selection effects in the market for commercial mortgage-backed securities (CMBS). In the CMBS market, informed portfolio lenders possess private information on loan quality and may seek to liquefy lower quality loans. Theoretical results show that sales of portfolio loans in securitization markets incorporate a "lemons discount". Conduit lenders, who originate loans for direct sale into

[25] We have also conducted additional robustness tests, for example, by classifying loan originators into commercial bank lenders and non-commercial bank lenders, and interact the bank indicator with the conduit dummy. The findings are largely robust to what we find here. These results are available from the authors upon request.

securitization markets and possess no private information on loan performance, may serve to mitigate those problems of asymmetric information and loan adverse selection. Our empirical estimates conform to theory. Results of reduced form pricing models at both the deal- and loan-level indicate that portfolio loans sold into securitization markets were priced 33 bps lower than conduit deals, after controlling for observable credit quality and other well-established determinants of CMBS pricing.

Our findings have important implications for the future of the mortgage derivatives market. Clearly, structural failings associated with the "originate-to-distribute" model require further business and policy scrutiny. However, results from this paper suggest that conduit lending may have alleviated information problems associated with commercial mortgage securitization and in so doing enhanced efficiency in the CMBS marketplace. Those benefits should be retained in ongoing efforts to re-structure and revitalize the commercial mortgage-backed securities markets.

Appendix: proof of proposition 1

The problem is

$$\max_p \left\{ \left[\sum_{\underline{v}}^{v[q(p)]} E\left(Y_i \mid V_i\right) - n \cdot q(p) \cdot p \right] + n \cdot \left[1 - q(p)\right] \cdot 0 \right\}, \qquad \text{(A.1)}$$

$$s.t.\ p \geq E\left[(1-\delta) Y_i \mid V_i\right]$$

where $q(p)$ is the share of loans sold in a mortgage pool, or equivalently, the probability of trade for each loan.

Since $Y_i = u + V_i + Z_i$, we can rewrite the condition of the trade as

$$p \geq (1-\delta)\left(u + V_i\right), \qquad \text{(A.2)}$$

and thus equation (A.1) is equivalent to

$$\max_p \left\{ n \cdot q(p) \cdot \left[E\left(Y_i \mid p \geq (1-\delta)\left(u + V_i\right)\right) - p \right] + n \cdot \left[1 - q(p)\right] \cdot 0 \right\}. \qquad \text{(A.3)}$$

Given that V_i is uniformly distributed over $[\underline{v}, \bar{v}]$, we can obtain the probability of a trade occurring as

$$F(p) = \frac{\frac{p}{1-\delta} - \left(u + \underline{v}\right)}{(\bar{v} - \underline{v})} \quad . \qquad \text{(A.4)}$$

Equation (A.4) suggests that, from the buyer's perspective, a higher offer price implies a higher probability of a trade taking place. However, the first $[\cdot]$ in equation (A.3) indicates that a higher offer price is accompanied by a lower profit for the buyer when a trade occurs. Since we have

$$\begin{aligned} E\left[Y_i \mid p \geq (1-\delta)\left(u + V_i\right)\right] - p &= \int_{\underline{v}}^{\frac{p}{1-\delta} - u} (u + v_i - p) \cdot \frac{1}{\frac{p}{1-\delta} - \left(u + \underline{v}\right)} dv_i \\ &= \frac{1}{2}[u + \underline{v} + \frac{2\delta - 1}{1-\delta} p] \end{aligned} \qquad \text{(A.5)}$$

from equations (A.4) and (A.5), we can further simplify equation (A.3) as

$$p^* = \arg\max_p \left\{ n \cdot \frac{\frac{p}{1-\delta} - \left(u + \underline{v}\right)}{(\bar{v} - \underline{v})} \cdot \frac{1}{2}[u + \underline{v} + \frac{2\delta - 1}{1-\delta} p] \right\}. \tag{A.6}$$

Given that the incremental holding cost is far less than 50 percent of the loan value, i.e. $\delta \ll .5$, equation (A.6) has an interior solution:

$$p^* = \frac{(1-\delta)^2}{1-2\delta}\left(u + \underline{v}\right). \tag{A.7}$$

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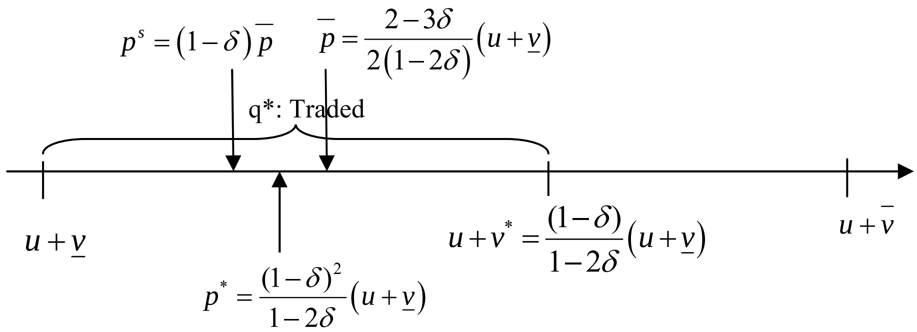

Fig. 1. Trading and pricing of portfolio loans

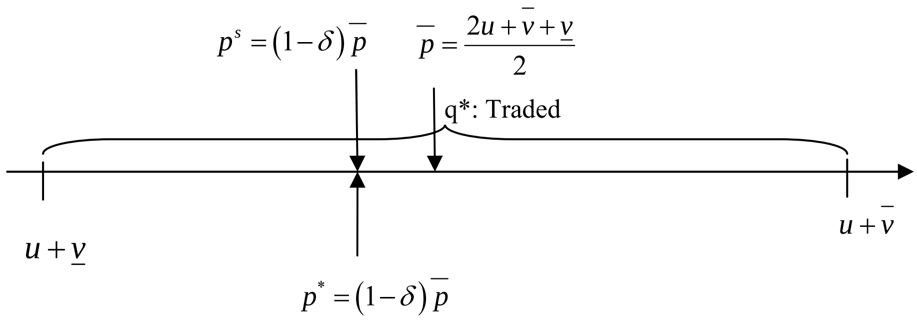

Fig. 2. Trading and pricing of conduit loans

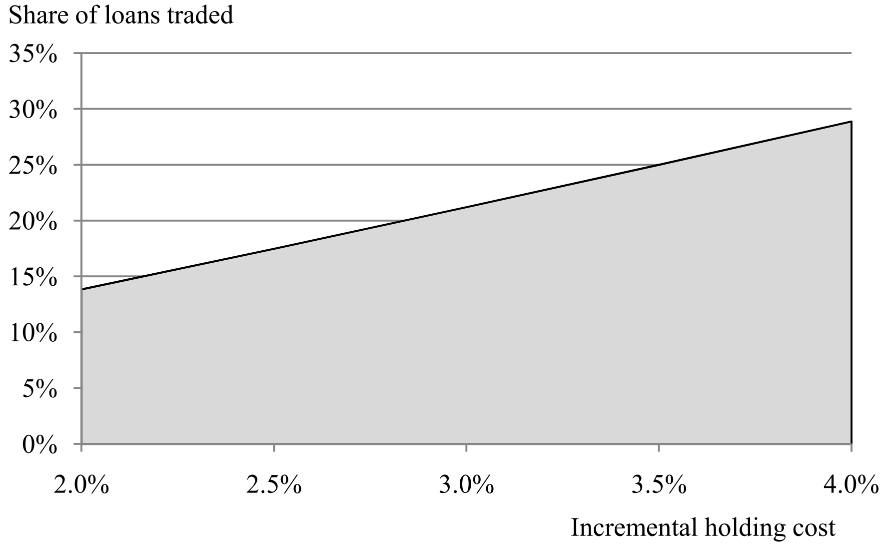

Fig. 3. Share of portfolio loans traded varies positively with the portfolio lender's incremental holding costs. Here, we assume a loan quality dispersion of 14 percent (the best and worst quality loans have a yield difference of 150 bps) due to unobservable differences in the value of V_i and then calculate the shares of portfolio loans sold when the seller's incremental holding cost increases from 2 percent to 4 percent of loan value. When portfolio lenders face only a 2 percent incremental holding cost, the share of loans traded is about 14 percent. The share increases to 29 percent when lenders face an incremental holding cost of 4 percent.

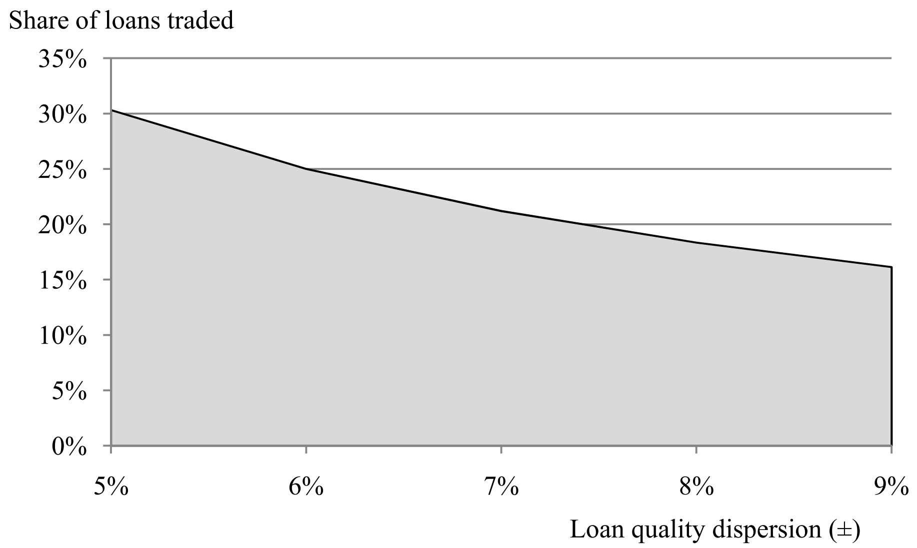

Fig. 4. Share of portfolio loans traded varies negatively with loan quality dispersion. Here, we assume a portfolio lender's incremental holding cost of 3 percent and calculate the share of portfolio loans sold when the loan quality dispersion increases from ± 5% to ± 9%. Those loan quality dispersion values represent yield differentials between high quality and low quality commercial mortgage loan (due to unobservable residual risk) ranging from 105 bps to 191 bps. In the case that loans in a commercial mortgage pool are characterized by a 105 bps yield differential (a relatively homogeneous pool), the share of loans traded is about 30 percent. The share of loans traded declines to 16 percent when loans in the commercial mortgage pool are characterized by yield differentials as high as 191 bps (a very heterogeneous pool).

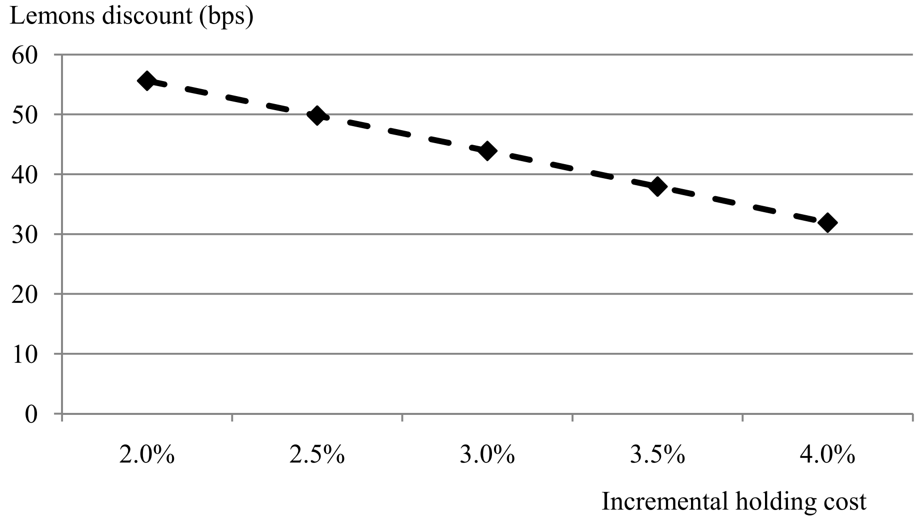

Fig. 5. The lemons discount varies negatively with seller's incremental cost of holding whole loans. Here, we assume that a typical commercial mortgage loan carries an 8 percent interest rate and has a 30 year amortization term and a 10 year maturity term. Given those parameter values, we calculate the "lemons discount" in accordance to proposition 3 and then convert it into basis point yield differentials. As shown in the figure, when the incremental holding cost is 2 percent of loan value, we observe a yield spread of 56 bps between conduit loans and portfolio loans (the "lemons discount"). The yield spread decreases to 32 bps when the incremental holding cost rises to 4 percent.

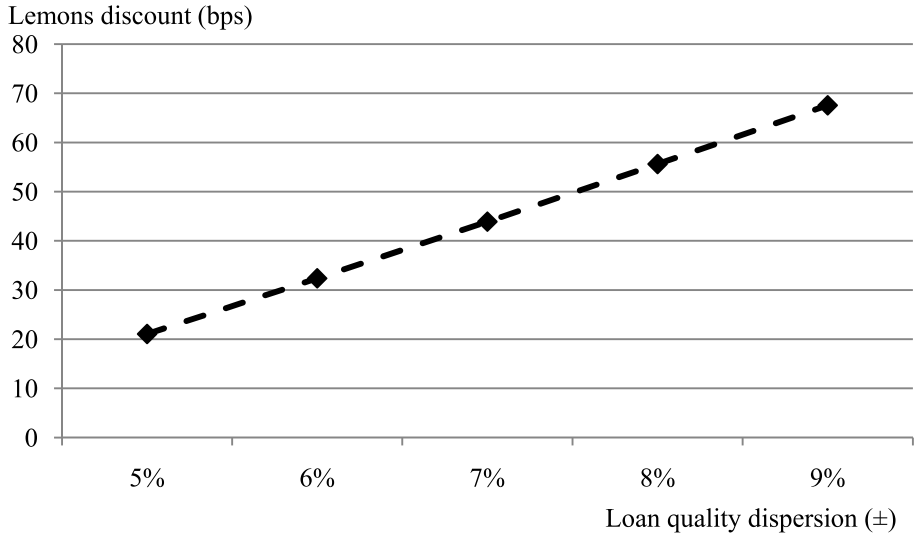

Fig. 6. The "lemons discount" varies positively with loan quality dispersion. Again, we assume that a typical commercial mortgage loan carries an 8 percent interest rate and has a 30 year amortization term and a 10 year maturity term. Further, we assume that the incremental holding cost of retaining whole loans in portfolio is 3 percent of loan value. Based on these parameter values, we calculate the "lemons discount" in accordance to proposition 3 and then convert it into basis point yield differentials. When the mortgage origination pool loan quality dispersion (dispersion in values of V_i) is $\pm$ 5%, the "lemons discount" is computed to be 21 bps. When the mortgage origination pool loan quality dispersion rises to $\pm$ 9%, the "lemons discount" increases to 68 bps.

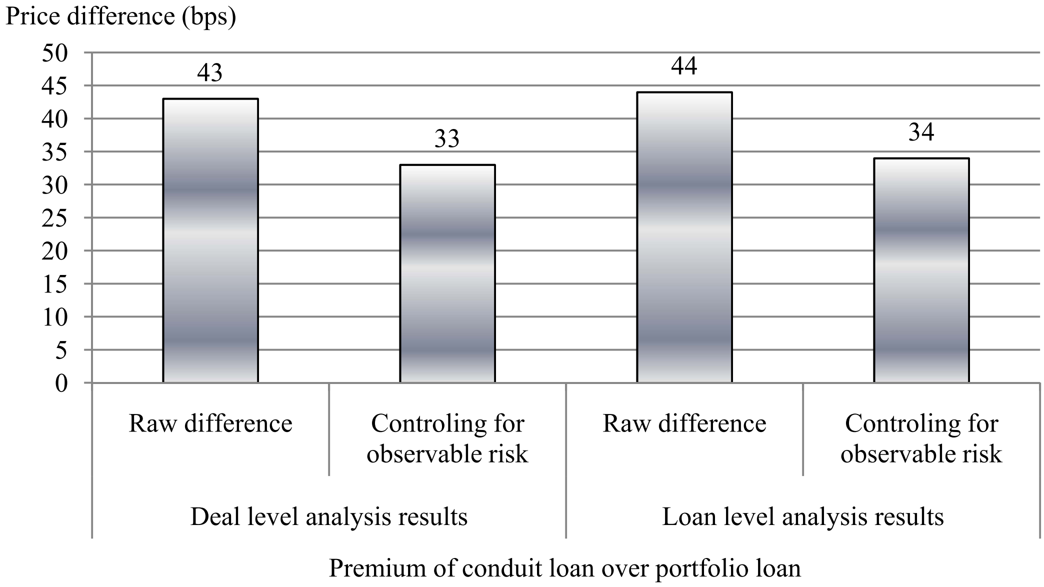

Fig. 7. Price difference between conduit loans and portfolio loans. This figure summarizes results of our empirical analysis as regards the basis point premium of conduit loans over portfolio loans. For example, our CMBS deal level analysis shows that after controlling for observable CMBS pool characteristics and other well-established determinants of CMBS pricing, conduit deals (loans) are priced 33 bps higher than portfolio loans.

Table 1 Comparison of CMBS Conduit Deal and Portfolio Deal Spreads

Deal type	Mean	Std Dev	Minimum	Median	Maximum	Number of obs.
Conduit	2.2615	0.5835	0.6613	2.2153	4.4804	118
Portfolio	2.6951	0.8825	1.4987	2.5879	5.0899	23

Note: The spread is calculated as the deal net coupon (paid to investors) minus comparable maturity treasury rate at deal cutoff. Linear interpolation is applied to treasury rates to obtain the full term structure.

Table 2 Cut off Year Distribution of the Conduit and Portfolio Deals in our Sample

	All deals		Conduit deals		Portfolio deals	
Cut off Year	Number of deals	Percent of total	Number of deals	Percent of total	Number of deals	Percent of total
1994	5	3.55	3	2.54	2	8.7
1995	18	12.77	13	11.02	5	21.74
1996	26	18.44	20	16.95	6	26.09
1997	23	16.31	20	16.95	3	13.04
1999	36	25.53	32	27.12	4	17.39
2000	33	23.4	30	25.42	3	13.04
Total	141	100.00	118	100.00	23	100.00

Note: A total of 141 CMBS deals cutoff during 1994 and 2000, not including 1998 in which there are no portfolio deals recorded. Of these deals, 118 are conduit deals and 23 are portfolio deals.

Table 3 Descriptive Statistics of CMBS Deals in our Sample

Variable	Mean	Std Dev	Minimum	Maximum
Deal spread	2.3322	0.6578	0.6613	5.0899
Conduit deal	0.8369	0.3708	0.0000	1.0000
Debt-service coverage ratio (DSCR) at deal cutoff	1.4338	0.1715	1.0400	2.3200
Weighted average maturity 10 ~ 20 years	0.6028	0.4911	0.0000	1.0000
Weighted average maturity > 20 years	0.0213	0.1448	0.0000	1.0000
Shares of multifamily loans	0.2858	0.2321	0.0000	1.0000
Shares of retail anchored property loans	0.1711	0.1760	0.0000	0.9338
Shares of office property loans	0.1528	0.1261	0.0000	0.5441
Shares of industrial property loans	0.0635	0.0820	0.0000	0.6239
Shares of retail unanchored property loans	0.1232	0.1561	0.0000	1.0000
Shares of healthcare property loans	0.0305	0.1128	0.0000	1.0000
Shares of full service hotel loans	0.0206	0.0414	0.0000	0.3414
Log of deal cutoff balance	20.1363	0.7076	18.1717	21.5883
Weights of the 5 largest loans in the deal	0.3664	0.2801	0.1066	1.0000
Prepayment coverage	0.9576	0.6465	0.0000	2.1301
Herfindahl index for loan size	0.0211	0.0304	0.0009	0.3441
Geographic diversification	0.8647	0.1069	0.0005	0.9735
Standard deviation of LTV at loan origination	9.7954	2.7022	5.6235	25.9052
Standard deviation of loan DSCR	0.5415	0.2225	0.1401	2.0162
Number of loans	149	87	22	558
Number of deals			141	

Note: The deal spread is calculated as the deal net coupon (paid to investors) minus comparable maturity treasury rate at deal cutoff. Prepayment coverage is calculated as the proportion of months covered by any of the following types of prepayment constraint: yield maintenance, lock out, prepayment penalty or defeasance. The Herfindahl index for loan size, geographic diversification, standard deviations of LTV and DSCR are calculated using loan level information for all loans in the deal.

Table 4 GLS Estimates of the CMBS Deal Spread Model

Dependent variable: The CMBS deal Weighted Average Coupon paid to investors (Net WAC), log deal balance used as the weight in the GLS estimation.

Variable	Model 1	Model 2	Model 3
Intercept	2.685***	3.514***	5.088***
	(0.133)	(0.334)	(0.501)
Focus variable			
Conduit deal	-0.427***	-0.257*	-0.329**
	(0.145)	(0.116)	(0.109)
Market conditions			
Corporate bond credit spread		0.952b	1.064*
		(0.516)	(0.439)
CMBS market cap		-0.007***	-0.008***
		(0.001)	(0.001)
Slope of the Yield Curve		-1.165***	-1.007***
		(0.133)	(0.12)
Interest rate volatility		2.342*	1.868b
		(1.181)	(1.09)
Previous quarter Sharpe ratio		0.011	0.019
of commercial real estate		(0.035)	(0.029)
CMBS pool characteristics			
Debt-service coverage ratio (DSCR) at deal cutoff			-0.178
			(0.235)
WAM between 10 to 20 years			-0.097
			(0.089)
WAM over 20 years			0.126
			(0.283)
Prepayment constraint coverage			0.320*
			(0.125)
Shares of multifamily loans			-1.063***
			(0.263)
Shares of anchored retail property loans			-0.786*
			(0.341)
Shares of office property loans			-0.689b
			(0.389)
Share of industrial loans			-1.226*
			(0.486)
Shares of unanchored retail property loans			-0.237
			(0.358)
Share of healthcare property loans			0.139
			(0.414)
Share of full service hotel loans			2.753**
			(0.981)
Herfindahl index for loan size			2.274b
			(1.289)
Geographic diversification			-0.918*

			(0.419)
Number of observations	141	141	141
Adjusted R-square	0.0516	0.4253	0.6022

NOTE: Standard errors are in parenthesis, ***- p < .001, ** - p < .01, * - p < .05 and b – p < .1. There are 118 conduit deals and 23 portfolio deals in our sample.

Table 5 Comparison of Spreads of CMBS Loans in Conduit and Portfolio Deals

Loan Type	Mean	Std Dev	Minimum	Median	Maximum	Number of obs.
Conduit	2.0984	0.7203	0.0150	2.0692	5.6800	13655
Portfolio	2.5701	0.9409	0.0425	2.5645	7.1404	3105

Note: The spread is calculated as the loan net coupon (paid to investors) minus comparable maturity treasury rate at deal cutoff. Linear interpolation is applied to treasury rates to obtain the full term structure.

Table 6 Cut off Year Distribution of the Loans in Sampled Conduit and Portfolio Deals

	All loans		Conduit loans		Portfolio loans	
Cut off Year	Number of loans	Percent of total	Number of loans	Percent of total	Number of loans	Percent of total
1994	332	1.98	180	1.32	152	4.9
1995	1,038	6.19	810	5.93	228	7.34
1996	2,118	12.64	1,713	12.54	405	13.04
1997	2,647	15.79	2,499	18.3	148	4.77
1999	6,739	40.21	4,950	36.25	1,789	57.62
2000	3,886	23.19	3,503	25.65	383	12.33
Total	16,760	100.00	13,055	100.00	3,105	100.00

Note: A total of 16,760 loans in 141 CMBS deals cutoff during 1994 and 2000, not including 1998 in which there are no portfolio deals recorded. 13,055 loans are in conduit deals and 3,105 loans are in portfolio deals.

Table 7 Descriptive Statistics of Sampled CMBS Loans

	Mean	STD	Minimum	Maximum
Spread	2.1955	0.7810	0.0167	7.1404
Loans in conduit deals	0.8147	0.3885	0.0000	1.0000
Loan-to-value ratio (LTV)	68.5743	10.9955	10.6900	125.0000
Amortization term ≤ 20 years	0.1553	0.3622	0.0000	1.0000
Amortization term > 30 years	0.0169	0.1288	0.0000	1.0000
Maturity term 10 ~ 20 years	0.1677	0.3736	0.0000	1.0000
Maturity term > 20 years	0.0232	0.1506	0.0000	1.0000
MIDWEST / EASTERN	0.0922	0.2894	0.0000	1.0000
MIDWEST / WESTERN	0.0334	0.1797	0.0000	1.0000
NORTHEAST / MID-ATLANTIC	0.1107	0.3137	0.0000	1.0000
NORTHEAST / NEW-ENGLAND	0.0452	0.2078	0.0000	1.0000
SOUTHERN / ATLANTIC	0.1847	0.3881	0.0000	1.0000
SOUTHERN / EAST-COAST	0.0305	0.1719	0.0000	1.0000
SOUTHERN / WEST-COAST	0.1465	0.3537	0.0000	1.0000
WESTERN / MOUNTAIN	0.1001	0.3001	0.0000	1.0000
WESTERN / NORTHERN PACIFIC	0.1116	0.3149	0.0000	1.0000
WESTERN / SOUTHERN PACIFIC	0.1450	0.3522	0.0000	1.0000
Prepayment constraint coverage	0.7361	0.3535	0.0000	1.4667
Quarter 2	0.2841	0.4510	0.0000	1.0000
Quarter 3	0.2137	0.4099	0.0000	1.0000
Quarter 4	0.2973	0.4571	0.0000	1.0000
Column	0.0828	0.2756	0.0000	1.0000
Bank of America	0.1430	0.3500	0.0000	1.0000
Wachovia	0.0790	0.2697	0.0000	1.0000
GE Capital	0.0431	0.2030	0.0000	1.0000
JPMorgan Chase	0.0476	0.2128	0.0000	1.0000
Lehman Brothers	0.0338	0.1806	0.0000	1.0000
Wells Fargo	0.0486	0.2150	0.0000	1.0000
GMAC	0.0436	0.2042	0.0000	1.0000
Nomura	0.0221	0.1471	0.0000	1.0000
CITI Group	0.0348	0.1834	0.0000	1.0000
Number of observations		16,760		

Table 8 GLS Estimates of the CMBS Mortgage Spread Model

Dependent variable: The net coupon paid to investors, log loan balance at deal cutoff used as the weight in the GLS estimation.

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	2.534***	3.126***	3.875***	4.151***
	(0.014)	(0.04)	(0.054)	(0.111)
Focus variable				
Loan in conduit deal	- 0.443***	-0.581***	-0.282***	-0.344***
	(0.015)	(0.014)	(0.016)	(0.017)
Market conditions				
Corporate bond credit spread		0.840***	0.633***	0.635***
		(0.058)	(0.055)	(0.056)
CMBS market cap		-0.005***	-0.005***	-0.006***
		(0)	(0)	(0)
Slope of the Yield Curve		-0.828***	-0.721***	-0.709***
		(0.017)	(0.016)	(0.016)
Interest rate volatility		3.771***	3.480***	3.943***
		(0.169)	(0.159)	(0.161)
Previous quarter Sharpe ratio of commercial real estate		-0.093***	-0.084***	-0.057***
		(0.009)	(0.008)	(0.008)
Loan characteristics				
Retail property loan			0.176***	0.159***
			(0.015)	(0.015)
Office property loan			0.170***	0.160***
			(0.012)	(0.012)
Industrial property loan			0.174***	0.170***
			(0.017)	(0.017)
Loan-to-value ratio (LTV)			-0.005***	-0.005***
			(0)	(0)
Amortization term ≤ 20 years			0.081***	0.095***
			(0.018)	(0.018)
Amortization term > 30 years			-0.227***	-0.216***
			(0.038)	(0.037)
Maturity term 10 ~ 20 years			-0.209***	-0.228***
			(0.015)	(0.015)
Maturity term > 20 years			-0.388***	-0.414***
			(0.034)	(0.034)
MIDWEST / EASTERN			-0.031	-0.045*
			(0.021)	(0.021)
MIDWEST / WESTERN			-0.066*	-0.071*
			(0.031)	(0.03)
NORTHEAST / MID-ATLANTIC			-0.014	-0.037
			(0.02)	(0.02)
NORTHEAST / NEW-ENGLAND			-0.039	-0.056*
			(0.027)	(0.027)
SOUTHERN / ATLANTIC			-0.059**	-0.078***

	(1)	(2)	(3)	(4)
			(0.018)	(0.018)
SOUTHERN / EAST-COAST			-0.036	-0.052
			(0.032)	(0.031)
SOUTHERN / WEST-COAST			0.031	0.019
			(0.019)	(0.019)
WESTERN / MOUNTAIN			-0.042*	-0.035
			(0.021)	(0.02)
WESTERN / NORTHERN PACIFIC			-0.020	-0.024
			(0.02)	(0.02)
Prepayment constraint coverage			-0.665***	-0.613***
			(0.017)	(0.017)
CMBS pool characteristics				
Weighted DSCR at deal cutoff				-0.105*
				(0.044)
Share of multifamily loans				-0.501***
				(0.06)
Share of retail anchored property loans				-0.497***
				(0.066)
Share of office loans				-0.512***
				(0.077)
Share of industrial loans				-0.789***
				(0.09)
Share of retail unanchored property loans				-0.733***
				(0.073)
Share of healthcare property loans				-0.867***
				(0.157)
Share of full service hotel loans				1.370***
				(0.173)
Herfindahl index for loan size				4.276***
				(0.618)
Geographic diversification				0.311***
				(0.093)
Number of Observations	16,760	16,760	16,760	16,760
Adjusted R-Square	0.0470	0.2154	0.3166	0.3317

NOTE: Standard errors are in parenthesis, ***- p < .001, ** - p < .01, * - p < .05. There are 13655 conduit loans and 3105 portfolio loans in our sample.

Table 9 Conduit and Portfolio Loan Spreads by Property Type

	Multifamily		Retail		Office		Industrial	
	Conduit	Portfolio	Conduit	Portfolio	Conduit	Portfolio	Conduit	Portfolio
Spread	2.0263 (0.7399)	2.2851 (0.9411)	2.1648 (0.6965)	2.5614 (0.954)	2.1574 (0.6757)	2.6752 (0.9386)	2.1237 (0.7434)	2.7222 (0.8737)
Difference	26***		40***		52***		60***	
N of obs.	6050	687	4231	844	2087	769	1287	805

NOTE: The spread is the difference between loan net coupon (paid to investors) and
*** indicates that the difference is significant at .1% significance level.

Table 10 GLS Estimates of the CMBS Mortgage Spread Model with Property Type Dummy Interactions

Dependent variable: The net coupon paid to investors, log loan balance at deal cutoff used as the weight in the GLS estimation.

Variable	Model 4
Intercept	4.066*** (0.112)
Focus variable	
Multifamily loan * Conduit deal	-0.239*** (0.027)
Retail loan * Conduit deal	-0.325*** (0.027)
Office loan * Conduit deal	-0.365*** (0.03)
Industrial loan * Conduit deal	-0.510*** (0.031)
Market conditions	
Corporate bond credit spread	0.637*** (0.056)
CMBS market cap	-0.006*** (0)
Slope of the Yield Curve	-0.712*** (0.016)
Interest rate volatility	3.954*** (0.162)
Previous quarter Sharpe ratio of commercial real estate	-0.057*** (0.008)
Loan characteristics	
Retail property loan	0.239***

	(0.035)
Office property loan	0.271***
	(0.035)
Industrial property loan	0.373***
	(0.035)
Loan-to-value ratio (LTV)	-0.005***
	(0)
Amortization term ≤ 20 years	0.087***
	(0.018)
Amortization term > 30 years	-0.218***
	(0.037)
Maturity term 10 ~ 20 years	-0.228***
	(0.015)
Maturity term > 20 years	-0.413***
	(0.034)
MIDWEST / EASTERN	-0.043*
	(0.021)
MIDWEST / WESTERN	-0.068*
	(0.03)
NORTHEAST / MID-ATLANTIC	-0.036
	(0.02)
NORTHEAST / NEW-ENGLAND	-0.054*
	(0.027)
SOUTHERN / ATLANTIC	-0.077***
	(0.018)
SOUTHERN / EAST-COAST	-0.052
	(0.031)
SOUTHERN / WEST-COAST	0.018
	(0.019)
WESTERN / MOUNTAIN	-0.032
	(0.02)
WESTERN / NORTHERN PACIFIC	-0.028
	(0.02)
Prepayment constraint coverage	-0.604***
	(0.017)
CMBS pool characteristics	
Weighted DSCR at deal cutoff	-0.105*
	(0.044)
Share of multifamily loans	-0.486***
	(0.06)
Share of retail anchored property loans	-0.482***
	(0.066)
Share of office loans	-0.491***
	(0.077)
Share of industrial loans	-0.768***
	(0.09)
Share of retail unanchored property loans	-0.718***
	(0.073)

Share of healthcare property loans	-0.860***
	(0.157)
Share of full service hotel loans	1.387***
	(0.173)
Herfindahl index for loan size	4.348***
	(0.618)
Geographic diversification	0.285**
	(0.093)
Number of Observations	16,760
Adjusted R-Square	0.3351

NOTE: Standard errors are in parenthesis, ***- p < .001, ** - p < .01, * - p < .05, and b – p< 0.10. There are 13655 conduit loans and 3105 portfolio loans in the sample.

Appendix Table 1 Names of CMBS Deals in our Sample

AETNA 1995-C5	FUNB 1999-C4	MLMI 1996-C2
AMRESCO 1997-C1	FUNB 2000-C1	MLMI 1997-C1
ASC 1995-D1	FUNB-CMB 1999-C2	MLMI 1997-C2
ASC 1996-D2	GECCMC 2000-1	MLMI 1999-C1
ASC 1996-D3	GMAC 1996-C1	MSCI 1995-GAL-1
BACM 2000-1	GMAC 1997-C1	MSCI 1996-BKU1
BACM 2000-2	GMAC 1999-C3	MSCI 1996-C1
BSCMS 2000-WF1	GMAC 2000-C1	MSCI 1996-WF1
BSCMS 2000-WF2	GMAC 2000-C2	MSCI 1997-ALIC
BSCMSI 1999-C1	GMAC 2000-C3	MSCI 1997-C1
BSCMSI 1999-WF2	GSMSCII 1996-PL	MSCI 1997-HF1
CAISSE 1999	GSMSCII 1999-C1	MSCI 1997-LB1
CCA1-2	HMAC 1999-PH1	MSCI 1997-WF1
CCMS 1996-1	HMAC 2000-PH1	MSCI 1999-CAM1
CCMS 1996-2	JPM 1995-C1	MSCI 1999-FNV1
CCMS 1997-1	JPM 1996-C2	MSCI 1999-RM1
CCMS 1997-2	JPM 1996-C3	MSCI 1999-WF1
CCMSC 1999-2	JPM 1997-C4	MSCI 2000-LIFE1
CCMSC 2000-1	JPM 1997-C5	MSDWC 2000-PRIN
CCMSC 2000-2	JPM 1999-C7	NASC 1994-C3
CCMSC 2000-3	JPM 1999-C8	NFC 1996-1
CMAC 1996-C1	JPMC 1999-PLS1	NFC 1999-1
CMAC 1999-C1	JPMC 2000-C10	NFC 1999-2
CMAT 1999-C1	JPMC 2000-C9	OCMI 1995-1
CMAT 1999-C2	KEY 2000-C1	PMAC 1996-M1
CMB-FUNB 1999-1	KPAC 1994-M1	PMAC 1999-C1
COMM 1999-1	LBCC 1995-C2	PMLI 1996-PML
COMM 2000-C1	LBCC 1996-C2	PNCMA 2000-C1
CSFB 1995-M1	LBUBS 2000-C3	PNCMAC 1999-CM1
CSFB 1995-MBL1	LBUBS 2000-C4	PNCMAC 2000-C2
CSFB 1995-WF1	LBUBS 2000-C5	PSSFC 1995-C1
CSFB 1999-C1	MCFI 1995-MC1	PSSFC 1995-MCF2
CSFB 2000-C1	MCFI 1996-MC1	PSSFC 1999-C2
DLJ 1994-MF11	MCFI 1996-MC2	PSSFC 1999-NRF1
DLJ 1995-CF2	MCFI 1997-MC1	RMF 1995-1
DLJ 1996-CF1	MCFI 1997-MC2	RMF 1997-1
DLJ 1996-CF2	MIDL 1996-C1	SASC 1995-C4
DLJ 1997-CF1	MIDL 1996-C2	SASC 1996-CFL
DLJ 1997-CF2	MLFA 1999-CAN2	SBMS 1996-C1
DLJ 1999-CG1	MLFA 2000-CAN3	SBMS 1999-C1
DLJ 1999-CG2	MLFA 2000-CAN4	SBMS 2000-C1
DLJ 1999-CG3	MLIC 1996-1	SBMS 2000-C2
DLJ 2000-CF1	MLMI 1994-C1	SBMS 2000-C3

DLJCMC 2000-CKP1	MLMI 1995-C1	SBMS-VII 2000-NL1
FUCMT 1999-C1	MLMI 1995-C2	SLCMT 1997-C1
FULB 1997-C1	MLMI 1995-C3	SMSC 1994-M1
FULB 1997-C2	MLMI 1996-C1	TIAA-RCMT 1999-1

Note: A total of 141 CMBS deals cutoff during 1994 and 2000, not including 1998 in which there is no portfolio deals recorded. Among these deals, 118 are conduit deals and 23 are portfolio deals.

Appendix Table 2 GLS Estimates of the CMBS Mortgage Spread Model Using DSCR rather than LTV

Dependent variable: The net coupon paid to investors, log loan balance at deal cutoff used as the weight in the GLS estimation.

Variable	Model 4
Intercept	3.224***
	(0.745)
Focus variable	
Loan in conduit deal	-0.224***
	(0.065)
Market conditions	
Corporate bond credit spread	2.078***
	(0.325)
CMBS market cap	-0.007***
	(0.001)
Slope of the Yield Curve	-1.197***
	(0.09)
Interest rate volatility	3.777***
	(0.792)
Previous quarter Sharpe ratio of commercial real estate	0.001
	(0.028)
Loan characteristics	
Debt-service coverage ratio (DSCR)	-0.092***
	(0.024)
Amortization term ≤ 20 years	0.125
	(0.074)
Amortization term > 30 years	0.223
	(0.141)
Maturity term 10 ~ 20 years	-0.190**
	(0.064)
Maturity term > 20 years	-0.381***
	(0.084)
MIDWEST / EASTERN	-0.069
	(0.089)
MIDWEST / WESTERN	-0.067
	(0.114)
NORTHEAST / MID-ATLANTIC	-0.128
	(0.084)
NORTHEAST / NEW-ENGLAND	0.026
	(0.104)
SOUTHERN / ATLANTIC	-0.143
	(0.074)
SOUTHERN / EAST-COAST	-0.111
	(0.117)
SOUTHERN / WEST-COAST	-0.016
	(0.074)
WESTERN / MOUNTAIN	-0.031

	(0.081)
WESTERN / NORTHERN PACIFIC	-0.023
	(0.095)
Prepayment constraint coverage	-0.323***
	(0.079)
CMBS pool characteristics	
Share of multifamily loans	-1.539***
	(0.369)
Share of retail anchored property loans	-0.536
	(0.353)
Share of office loans	-0.825
	(0.451)
Share of industrial loans	-0.946
	(0.701)
Share of retail unanchored property loans	-0.929*
	(0.468)
Share of healthcare property loans	-0.450
	(0.522)
Share of full service hotel loans	2.333*
	(1.155)
Herfindahl index for loan size	2.191
	(2.339)
Geographic diversification	0.784
	(0.647)
Number of Observations	1,064
Adjusted R-Square	0.4334

NOTE: This is a robustness check on whether using DSCR rather than LTV affects model results. The model specification is the same as that in Table 9 model 4, except that the pool level weighted average DSCR is dropped from the regression because it is highly correlated with the loan DSCR. Standard errors are in parenthesis, ***- p < .001, ** - p < .01 and * - p < .05. There are 861 conduit loans and 203 portfolio loans in the sample.

Appendix Table 3 GLS Estimates of the CMBS Mortgage Spread Model with 25 Originator Dummies

Dependent variable: The net coupon paid to investors, log loan balance at deal cutoff used as the weight in the GLS estimation.

Variable	Model 4
Intercept	4.216***
	(0.117)
Focus variable	
Loan in conduit deal	-0.261***
	(0.024)
Market conditions	
Corporate bond credit spread	-0.497***
	(0.054)
CMBS market cap	-0.006***
	(0)
Slope of the Yield Curve	-0.447***
	(0.015)
Interest rate volatility	4.471***
	(0.19)
Previous quarter Sharpe ratio	-0.055***
of commercial real estate	(0.009)
Loan characteristics	
Loan-to-value ratio (LTV)	-0.006***
	(0.001)
Amortization term ≤ 20 years	0.084***
	(0.018)
Amortization term > 30 years	-0.188***
	(0.039)
Maturity term 10 ~ 20 years	-0.190***
	(0.016)
Maturity term > 20 years	-0.297***
	(0.035)
MIDWEST / EASTERN	-0.047*
	(0.022)
MIDWEST / WESTERN	-0.058
	(0.031)
NORTHEAST / MID-ATLANTIC	-0.044*
	(0.021)
NORTHEAST / NEW-ENGLAND	-0.060*
	(0.028)
SOUTHERN / ATLANTIC	-0.071***
	(0.019)
SOUTHERN / EAST-COAST	-0.024
	(0.032)
SOUTHERN / WEST-COAST	0.040*
	(0.02)
WESTERN / MOUNTAIN	-0.037

	(0.021)
WESTERN / NORTHERN PACIFIC	-0.055**
	(0.02)
Prepayment constraint coverage	-0.595***
	(0.018)
Loan Originator	
Column Financial	0.266***
	(0.022)
Bank of America	-0.005
	(0.024)
Wachovia	0.042
	(0.024)
GE Capital	-0.189***
	(0.028)
JPMorgan Chase	-0.096***
	(0.027)
Lehman Brothers	-0.050
	(0.034)
Wells Fargo	-0.469***
	(0.031)
GMAC	-0.049
	(0.028)
Nomura	0.113**
	(0.039)
CITI Group	-0.035
	(0.031)
Midland	-0.137***
	(0.03)
Merrill Lynch	0.090**
	(0.033)
UBS	-0.041
	(0.033)
Morgan Stanley	-0.151***
	(0.038)
Conti	0.038
	(0.052)
Bear Sterns	-0.218***
	(0.039)
Key Bank	0.265***
	(0.04)
GACC	-0.183***
	(0.039)
Greenwich	-0.055
	(0.042)
Protective	0.069
	(0.071)
Provident	0.341***
	(0.062)

General American	0.078
	(0.06)
Confederation Life	0.342***
	(0.076)
Principal	-0.680***
	(0.054)
Penn Mutual	-0.445***
	(0.078)
CMBS pool characteristics	
Weighted DSCR at deal cutoff	0.264***
	(0.052)
Share of multifamily loans	-0.449***
	(0.067)
Share of retail anchored property loans	-0.284***
	(0.078)
Share of office loans	-1.411***
	(0.087)
Share of industrial loans	-0.581***
	(0.1)
Share of retail unanchored property loans	-0.126
	(0.082)
Share of healthcare property loans	-0.980***
	(0.171)
Share of full service hotel loans	1.620***
	(0.187)
Herfindahl index for loan size	2.488***
	(0.72)
Geographic diversification	-0.349***
	(0.103)
Number of Observations	16,760
Adjusted R-Square	0.3001

NOTE: Standard errors are in parenthesis, ***- p < .001, ** - p < .01, * - p < .05, and b – p< 0.10. There are 13,655 conduit loans and 3,105 portfolio loans in the sample.

Appendix Table 4 GLS Estimates of the CMBS Mortgage Spread Model by Property Type

Dependent variable: The net coupon paid to investors, log loan balance at deal cutoff used as the weight in the GLS estimation.

Variable	Multifamily	Retail	Office	Industrial
Intercept	3.466***	5.372***	3.474***	5.076***
	(0.196)	(0.196)	(0.266)	(0.303)
Focus variable				
Loan in conduit deal	-0.320***	-0.391***	-0.341***	-0.541***
	(0.029)	(0.03)	(0.041)	(0.047)
Market conditions				
Corporate bond credit spread	1.149***	0.245*	0.204	0.393*
	(0.084)	(0.096)	(0.142)	(0.181)
CMBS market cap	-0.006***	-0.006***	-0.005***	-0.006***
	(0)	(0)	(0)	(0)
Slope of the Yield Curve	-0.846***	-0.651***	-0.514***	-0.555***
	(0.024)	(0.03)	(0.04)	(0.053)
Interest rate volatility	4.669***	3.920***	3.408***	3.269***
	(0.265)	(0.269)	(0.415)	(0.53)
Previous quarter Sharpe ratio	-0.079*	-0.201***	-0.190***	-0.084***
of commercial real estate	(0.037)	(0.038)	(0.027)	(0.014)
Loan characteristics				
Loan-to-value ratio (LTV)	-0.005***	-0.007***	-0.002	-0.004**
	(0.001)	(0.001)	(0.001)	(0.001)
Amortization term ≤ 20 years	0.069	-0.036	0.193***	0.169***
	(0.037)	(0.029)	(0.039)	(0.041)
Amortization term > 30 years	-0.192***	-0.158*	-0.304***	-0.167
	(0.053)	(0.074)	(0.075)	(0.206)
Maturity term 10 ~ 20 years	-0.190***	-0.199***	-0.169***	-0.329***
	(0.026)	(0.026)	(0.037)	(0.042)
Maturity term > 20 years	-0.271***	-0.428***	-1.151***	-0.381*
	(0.044)	(0.055)	(0.198)	(0.194)
MIDWEST / EASTERN	0.009	-0.062	-0.017	-0.008
	(0.034)	(0.036)	(0.053)	(0.066)
MIDWEST / WESTERN	0.011	-0.089	-0.180*	-0.107
	(0.045)	(0.053)	(0.075)	(0.108)
NORTHEAST / MID- ATLANTIC	0.099**	-0.116***	-0.145**	0.106
	(0.034)	(0.035)	(0.045)	(0.06)
NORTHEAST / NEW-ENGLAND	0.153***	-0.171***	-0.204***	0.049
	(0.046)	(0.044)	(0.059)	(0.082)
SOUTHERN / ATLANTIC	0.058	-0.143***	-0.142***	-0.025
	(0.031)	(0.03)	(0.043)	(0.053)
SOUTHERN / EAST-COAST	-0.022	-0.029	-0.100	0.117
	(0.046)	(0.051)	(0.09)	(0.18)
SOUTHERN / WEST-COAST	0.119***	0.011	-0.025	-0.030
	(0.03)	(0.035)	(0.054)	(0.061)
WESTERN / MOUNTAIN	0.024	-0.042	-0.102*	-0.013

	(0.035)	(0.035)	(0.047)	(0.053)
WESTERN / NORTHERN PACIFIC	0.035	-0.003	-0.108**	-0.047
	(0.038)	(0.038)	(0.041)	(0.042)
Prepayment constraint coverage	-0.556***	-0.587***	-0.636***	-0.674***
	(0.029)	(0.031)	(0.039)	(0.045)
CMBS pool characteristics				
Weighted DSCR at deal cutoff	-0.167*	-0.001	0.231*	-0.659***
	(0.068)	(0.08)	(0.11)	(0.153)
Share of multifamily loans	-0.573***	-0.452***	0.531**	-0.042
	(0.087)	(0.121)	(0.195)	(0.226)
Share of anchored retail loans	-0.366**	-0.708***	-0.203	-0.888***
	(0.118)	(0.108)	(0.175)	(0.22)
Share of office loans	-0.397**	-0.243	-0.253	-0.701**
	(0.123)	(0.136)	(0.201)	(0.239)
Share of industrial loans	-0.941***	-1.044***	-1.281***	-0.897***
	(0.164)	(0.156)	(0.255)	(0.217)
Share of unanchored retail loans	-0.604***	-1.092***	-0.523**	-0.701**
	(0.122)	(0.126)	(0.193)	(0.216)
Share of healthcare property loans	-1.012***	-1.422***	0.137	-0.305
	(0.209)	(0.323)	(0.539)	(0.567)
Share of full service hotel loans	1.048***	1.031***	1.688***	1.926**
	(0.265)	(0.291)	(0.462)	(0.618)
Herfindahl index for loan size	2.077*	6.038***	9.468***	22.225***
	(0.939)	(1.042)	(1.911)	(2.41)
Geographic diversification	0.679***	-0.394*	0.333	0.402
	(0.168)	(0.165)	(0.238)	(0.234)
Number of Observations	6,737	5,075	2,856	2,092
Adjusted R-Square	0.3313	0.3588	0.3414	0.3786

NOTE: This is a robustness check on whether running the regression by property type affects model results. The model specification is the same as that in Table 9 model 4. Standard errors are in parenthesis, ***- p < .001, ** - p < .01 and * - p < .05.

Appendix Table 5 GLS Estimates of the CMBS Mortgage Spread Model with Stratified Sample

Variable	1994	1995	1996	1997	1999	2000
Intercept	-2.880	4.138***	4.657***	5.948***	2.298***	1.543***
	(1.856)	(1.032)	(1.054)	(0.515)	(0.339)	(0.323)
Focus variable						
Loan in conduit deal	-0.388**	-0.414***	-0.412***	-0.389***	-0.385***	-0.344***
	(0.134)	(0.093)	(0.072)	(0.072)	(0.035)	(0.05)
Market conditions						
Corporate bond credit spread	9.080**	0.717	7.269***	3.140***	2.018***	3.171***
	(2.755)	(1.487)	(1.404)	(0.417)	(0.116)	(0.146)
Interest rate volatility	1.328	7.044***	5.048***	1.273**	1.817***	4.469***
	(2.141)	(0.711)	(0.841)	(0.414)	(0.5)	(0.345)
Previous quarter Sharpe ratio	-0.314***	-0.239**	-0.043	-0.033***	-0.079***	-0.052**
of commercial real estate	(0.091)	(0.077)	(0.029)	(0.01)	(0.015)	(0.016)
Loan characteristics						
Loan-to-value ratio (LTV)	-0.013***	-0.010***	-0.007***	-0.008***	-0.006***	-0.001
	(0.003)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Amortization term ≤ 20 years	-0.007	-0.032	0.061	0.024	0.100***	0.038
	(0.198)	(0.066)	(0.056)	(0.033)	(0.026)	(0.04)
Amortization term > 30 years	-1.760***	-0.252	0.118	-0.296***	-0.315***	-0.150**
	(0.414)	(0.241)	(0.334)	(0.082)	(0.058)	(0.052)
Maturity term 10 ~ 20 years	-0.169	-0.199***	-0.248***	-0.187***	-0.266***	-0.195***
	(0.132)	(0.059)	(0.053)	(0.028)	(0.023)	(0.036)
Maturity term > 20 years	-0.328*	-0.455***	-0.026	-0.288***	-0.452***	-0.446***
	(0.164)	(0.098)	(0.084)	(0.057)	(0.065)	(0.128)
MIDWEST / EASTERN	0.282	-0.186*	0.051	-0.029	-0.080*	0.049

	(0.194)	(0.09)	(0.064)	(0.042)	(0.034)	(0.037)
MIDWEST / WESTERN	-0.309	-0.008	-0.027	-0.014	-0.108*	-0.053
	(0.242)	(0.123)	(0.102)	(0.051)	(0.047)	(0.055)
NORTHEAST / MID-ATLANTIC	0.146	0.125	0.049	-0.001	-0.055	0.004
	(0.172)	(0.103)	(0.066)	(0.039)	(0.032)	(0.035)
NORTHEAST / NEW-ENGLAND	0.031	-0.041	0.150	0.019	-0.117**	0.021
	(0.305)	(0.118)	(0.084)	(0.049)	(0.044)	(0.044)
SOUTHERN / ATLANTIC	-0.276	-0.050	0.076	-0.095**	-0.150***	0.045
	(0.182)	(0.078)	(0.057)	(0.035)	(0.028)	(0.033)
SOUTHERN / EAST-COAST	0.222	0.002	0.275***	-0.033	-0.253***	-0.044
	(0.217)	(0.112)	(0.081)	(0.055)	(0.055)	(0.064)
SOUTHERN / WEST-COAST	0.042	-0.030	0.072	-0.025	-0.099**	0.145***
	(0.161)	(0.08)	(0.058)	(0.036)	(0.03)	(0.035)
WESTERN / MOUNTAIN	-0.346*	0.060	0.131	-0.001	-0.072*	0.004
	(0.171)	(0.089)	(0.069)	(0.04)	(0.03)	(0.039)
WESTERN / NORTHERN PACIFIC	0.070	-0.043	0.011	-0.047	-0.084**	-0.006
	(0.173)	(0.112)	(0.086)	(0.046)	(0.026)	(0.039)
Prepayment constraint coverage	-0.607***	0.016	0.283*	0.105	-0.797***	-0.496***
	(0.127)	(0.083)	(0.111)	(0.088)	(0.03)	(0.032)
CMBS pool characteristics						
Weighted DSCR at deal cutoff	-0.023	-0.653	-0.256*	-0.488**	-0.889***	1.068***
	(0.217)	(0.5)	(0.118)	(0.182)	(0.162)	(0.105)
Share of multifamily loans	—	-0.512**	-2.151***	-0.866***	1.082***	2.289***
	—	(0.193)	(0.177)	(0.178)	(0.222)	(0.177)
Share of retail anchored property loans	—	0.067	-1.922***	-0.623***	0.612***	-1.511***
	—	(0.305)	(0.168)	(0.169)	(0.165)	(0.178)
Share of office loans	—	-0.489	-2.696***	0.373	1.055***	-0.997***
	—	(0.558)	(0.346)	(0.238)	(0.241)	(0.187)

Share of industrial loans	—	-0.294	-2.780***	-0.420	-2.160***	-3.376***
	—	(0.228)	(0.411)	(0.23)	(0.335)	(0.331)
Share of retail unanchored property loans	—	-0.720***	-3.797***	-0.157	0.866***	-2.821***
	—	(0.189)	(0.198)	(0.185)	(0.252)	(0.37)
Share of healthcare property loans	—	-3.931	-6.349***	-0.819***	-2.586***	-15.435***
	—	(2.36)	(0.595)	(0.223)	(0.558)	(1.343)
Share of full service hotel loans	—	0.878	-6.715***	-0.662	0.802*	-0.038
	—	(0.703)	(0.664)	(0.486)	(0.377)	(0.41)
Herfindahl index for loan size	—	9.275	0.468	10.555***	6.072**	-0.204
	—	(10.362)	(1.649)	(2.282)	(2.29)	(1.92)
Geographic diversification	—	—	-0.030	-0.143	-0.058	-2.122***
	—	—	(0.38)	(0.575)	(0.262)	(0.307)
Number of Obs.	332	1038	2118	2647	6739	3386
Adjusted R-square	0.2998	0.2451	0.3742	0.2207	0.4028	0.3299

Note: These are weighted-least square regression results. Log balance is used as the weight. Standard errors are in parenthesis, ***- p < .001, ** - p < .01, * - p < .05, and b – p< 0.10. Some variables are omitted from the explanatory variable list due to singularity problem – there's not enough variation in those variables.