

# **Risk and Information Tranching, Security Governance, And Incentive Compatible Capital Structure Design**

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## **I. Introduction**

In the aftermath of the financial crisis, the private-label residential mortgage-backed securities market was roundly criticized for its poor structures and failing to manage conflicts between agents participating up and down the security production/management supply chain. This created an impression that *all* securitization was fundamentally flawed, that investors were naïve in their dealings with other market participants, and that issuers rigged the system in their favor.<sup>2</sup> In contrast to the residential side of the market, however, the structuring of CMBS has generally held up well and can be trumpeted (albeit modestly) as a structured securities market success story. This research explores a particular (rather subtle) structural aspect of CMBS that may have contributed to its relative success, showing that conflicts were in fact anticipated by issuers and market participants, being managed through what economists refer to as “mechanism design.”

Well before the financial crisis occurred, one of the biggest concerns in CMBS production was how conflicts between senior and junior securityholders would be resolved in terms of dealing with distressed borrowers (see, for example, Riddiough (1997) and Riddiough and Zhu (2012)).<sup>3</sup> In this research we show how security pricing and capital structure mechanism design can be (and in fact was) used in the structured securities market to mitigate potential conflict between securityholders. In particular, we show that selling the senior security at a premium to par can help manage the anticipated conflict and, in the process, increase issuance proceeds from senior bond sales as a result of lower required subordination levels.

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<sup>2</sup> An exception is Benmelech, Dlugosz and Ivashina (2012), who study the collateralized loan obligation (CLO) market for lower rated corporate bonds that have been syndicated.

<sup>3</sup> See Riddiough (1997) and Riddiough and Zhu (2012) for more details.

The basic idea is as follows. All else equal, senior securityholders generally prefer liquidation in default, since this prevents a bad situation from becoming worse and hence preserves subordination level as credit insurance. In contrast, junior securityholders generally prefer workout in default, since this delays incurring a loss and introduces some upside potential. If properly managed, workout is often more efficient than liquidation since it avoids deadweight costs of foreclosure. But delay, especially delay associated with defaulted borrowers that are poor property managers, introduces the risk of greater losses which in turn requires higher subordination levels. By selling the senior security at a premium to par the senior securityholder is less interested in liquidation, since liquidation implies forfeiting a generous coupon payment stream. Continuation through workout helps preserve the payout stream and consequently tilts the senior securityholder's interests away from liquidation and towards forbearance. In the process issuance proceeds increase due to less concern over inefficient reorganizations which increase security principal loss risk.

The theory we develop is simple and intuitive, and generates a number of interesting implications. First, we show that senior security coupon payments and subordination levels can depend on the senior security investor clientele, where investors can differ in their demands for fully "safe" versus "information insensitive" securities. Investors that demand safe investments never expect to lose principal, which predicts the creation of "super-senior" AAA-rated securities. On the other hand, investors that are willing to accept a small risk of principal loss as long as that risk is not contaminated by information problems that introduce value-depleting conflicts of interest (which we label as information insensitive) can be matched up with at-the-margin (junior) AAA-rated securities. We also show that better diversified asset pools reduce the risk of severe principal loss based on the law of large numbers, implying both a decrease in subordination levels (an increase in issuance proceeds) and a migration of the "safe" investor clientele into at-the-margin securities.

The model also predicts that better-informed junior securityholders control liquidation-reorganization decisions, which coincides with the observed governance structure of the CMBS market. Senior securityholders lack the information necessary to distinguish between good and bad risks in reorganization, and therefore are incapable of making efficient decisions on a case-by-case basis. But junior securityholder control is only necessary for efficient governance outcomes to occur, and by itself it is not sufficient since junior securityholders will excessively reorganize loans without additional incentives to do otherwise. This is where coupon payments as an

incentive compatible payoff come in. Since reorganization implies continued funding of a relatively high coupon payment to senior bondholders, which comes at the expense of residual payoffs that would otherwise be available to junior bondholders, the junior bondholders will only reorganize and extend those loans that have a sufficiently high probability of success. Inefficient borrowers are eliminated through liquidation, as they should be. Thus a properly structured incentive compatible payoff (coupon payment), going from the controlling junior securityholder to the senior securityholder, with payment contingent on reorganization, can generate outcomes that reduce subordination levels as well as result in efficient governance decision outcomes.

The theory predicts that incentive compatible payoffs decline (senior security prices relative to par decline) with better diversified asset pools, when future market conditions are expected to deteriorate, and when collateral assets are more management intensive and specific. All three predictions are supported by the data, which include an analysis of all at-the-margin AAA-rated CMBS issued during the period going from 2004 to 2007. In 2007, a year in which both property and financial market conditions began to deteriorate, causing investors to revise expectations downward regarding liquidation proceeds from defaulted loans, senior security prices declined relative to par, as predicted. Larger, better diversified pools were also issued at lower prices relative to par, as were deals that included more management intensive-specific hotel property and larger (and thus harder to manage) assets.

In summary, in the paper we introduce a novel theory that explains security tranching not only based on fundamental credit risks but also based on information frictions, the optimal governance of these tranching securities, and how to achieve incentive compatible capital structure design through security tranching and proper governance structure. The data support predictions of the theory, which lends credibility to the assertion that at least certain securitization product markets were intelligently structured and fairly managed. The theory is also highly normative in its content, laying out a roadmap for private market participants as well as policymakers on how to increase the “goods” associated with securitization while at the same time reducing the “bads,” and doing so based on incentives rather than red tape.

## II. Theory

### II.A. Basic Model Structure and Preliminary Results

Consider a collateralized loan in which lender recourse in the case of default is limited to the available collateral asset. Current time is  $t=0$ . The debt matures in one period,  $t=1$ , with principal and interest due at that time.

The asset collateralizing the loan is risky in the sense that its time  $t=1$  payoff is uncertain. At  $t=1$  collateral asset value is such that in a good state it can be liquidated to fund the full repayment of the loan. However, in a bad state there is insufficient collateral asset value to fully repay the loan. The borrower defaults as a result, willing to exchange the asset for a release in its obligation to fully repay the loan. Our primary focus in this paper will be on the loan's  $t=0$  liquidity in relation to the consequences of borrower default.

As of time  $t=1$  the fundamental or “going concern” value of the collateral asset in a bad state is  $\Lambda^B$ . The bad state is the result of a common shock that hits all assets in the sector. The going concern value of  $\Lambda^B$  presumes asset management by an industry insider that is not subject to adverse effects of financial distress. However, because the entire collateral asset sector is hit with a common shock, there may be a shortage of industry insider expertise available to step up and purchase the asset should it be offered for sale. This causes the liquidation value of the asset (the value immediately realized as a result of a sale to an industry outsider) to be less than or equal to its going concern value (Shleifer and Vishny (1992)). Specifically, let the liquidation discount based on a sale of the collateral asset at time  $t=1$  equal  $\gamma \geq 0$ , where  $\gamma$  is such that  $\Lambda^B - \gamma > 0$ .

Now suppose that at the current time,  $t=0$ , the lender has liquidation incentives to remove as much of the loan from its balance sheet as is feasible, without having to sell at a discount, and where liquidation incentives are non-verifiable by outsiders. Information frictions exist that constrain the owner's ability to realize full value on a whole loan sale to outside investors. We will be explicit about the nature of the information frictions shortly. Further suppose outside investor clienteles exist that will pay more for loans and pools of loans whose credit risk is appropriately tranced than for credit risk that is simply pooled but not tranced (see, e.g., Riddiough (1997) and DeMarzo and Duffie (1999)). In particular, assume that the greatest investor demand

applies to securities that are “safe,” in the sense that a full payoff of the security’s face value is assured regardless of the state of the world.<sup>4</sup>

The properly designed security determines the optimal liquidating contract. To facilitate the loan-security sale the lender sets up a special purpose vehicle (SPV)—in effect a “new firm” that is bankruptcy remote. Assets of the SPV are the collateralized loan in question, with a liability structure based on the securities issued against the loan. At this point it is sufficient to consider two securities issued against the loan: a safe senior security that is a liquidating debt contract and a risky junior security. Because the senior security is immunized against the risk of principal loss, it is deemed “safe” and can be sold at a price that equals its full information value. The risky, informationally sensitive junior security can only be sold at a significant discount to uninformed outsiders. Consequently, it is held by the original owner.

We will now consider optimal liability structure design of the SPV. Assume that, when information is complete with respect to payoffs and the probability distribution functions (*pdf's*) governing those payoffs, all agents are risk neutral and that the discount rate is zero. For senior securityholders, a necessary condition for participation is that the investment is “safe” as previously defined. If the security structure fails to satisfy this requirement, the senior investor clientele vanishes and the security can only be sold at a discount to its full information value. The discount is sufficiently large so as always provide incentives for the seller to meet the “safe” security structure participation constraint.<sup>5</sup> With the “safe” senior security requirement, and given the liquidation incentives of the seller, the optimal capital structure for of the SPV is seen to be one in which the senior liquidating security is as large as possible while meeting the constraint for senior security participation.

Increasing liquidation proceeds through tranching is not without costs, however. The introduction of distinct securities creates a securities governance problem that did not exist with a single informed loan owner.

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<sup>4</sup> Cabellero (2006) has isolated the global investor demand for lower risk securities, which Bernanke et al. (2011) uses to support their arguments of the distortionary effects of global capital flows on securities markets and asset prices. At a more granular level, many others have argued that distortionary capital reserving requirements exacerbate the demand for higher-rated, lower-risk fixed income securities. Oldfield (2000) develops a demand-side elasticity-based theory to explain why tranching security values can exceed non-tranching value. Allen and Gale (1988) provide a similar rationale based on incomplete markets and risk aversion.

<sup>5</sup> For example, when an outside investor possesses less than full information may apply “unraveling” investment logic based on adverse selection incentives by presuming the worst in assessing the distribution of possible payoffs. For a probability density function that has sufficient variance, the costs of introducing information sensitivity in payoffs exceeds the benefits.

There are three dimensions to the governance problem that are interrelated: coordination costs, security payoff differences that distort incentives, and information disparities. The issue we address in detail is the implementation of efficient securities governance while also achieving optimal securities design.

Now, given a bad state sector-level realization that results in borrower default, there are two potential responses by the governing agents of the SPV: eliminating the current management team through immediate liquidation and sale of the asset for  $\Lambda^B - \gamma$ , or reorganization that retains the current management team and extends the loan repayment date for an additional period in hopes of increasing repayment proceeds.

Consider first circumstances in which borrower default results in immediate liquidation with complete certainty. This outcome could, for example, be codified into a governing servicing agreement as part of the SPV. The following lemma states the optimal security design in this case.

*Lemma 1: For the senior security to satisfy the “safe” investment criteria and to also satisfy the seller’s objective that the senior security be as large as possible in order to maximize issuance proceeds, the senior security will have a face value that exactly equals  $\Lambda^B - \gamma$ .*

*Proof: Any face value greater than this amount introduces the sure risk of principal loss, which implies the senior security is no longer marketable as such. Conversely, any face value less than this amount will not maximize issuance proceeds. Consequently the optimal senior security face value is exactly  $\Lambda^B - \gamma$ . QED*

With liquidation of the loan at the senior security’s face value of  $\Lambda^B - \gamma$ , the senior security is a safe, risk-free investment. As a consequence it can be sold at its par value of  $\Lambda^B - \gamma$ . Payoffs to the junior security are the residual cash flows from loan payoff in a good state and zero in a bad state with immediate liquidation. There are no governance issues related to control or decision rights in this case, since liquidation is the only option available to securityholders.

But immediate liquidation may be inefficient, since a reorganization that leaves the current (insider) management team in place may generate a continuation value that exceeds the liquidation payoff. Senior securityholders whose payoffs are fully protected in liquidation are insensitive to the costs associated with excess liquidation outcomes. Moreover, although reorganization may be efficient, the introduction of additional downside risk from continuation will, in the absence of compensating factors, require reductions in the face value of the senior security (see Longstaff (1990) for more on the financial behavior of extension options). The

junior securityholder (the original lender and seller of the senior security) as residual claimant bears the cost of inefficient liquidation decisions, which creates incentives to explore security-governance structures that increase liquidation proceeds while also maximizing the value of the residual claim.

Inefficiencies from excess liquidation occur as follows. Suppose that as an alternative to immediate liquidation, a reorganization can occur in which the incumbent management team is retained and the loan is restructured by extending its maturity one period. The value of the collateral asset at the end of that period will either be  $A^B+x$  or  $A^B-x$ ,  $x>0$ , at which point the asset is liquidated with proceeds distributed to securityholders based on absolute priority. To make things interesting and realistic, assume that  $x>\gamma$ , implying asset value resulting from a maturity extension in a low-value state is less than the value from immediate liquidation (i.e., there is downside risk associated with extension).

In order to streamline the exposition, also assume that the time  $t=1$  initial sector-wide shock is deep enough so that  $A^B+x$  resulting from a good extension outcome is insufficient to fully fund the borrower's loan payoff with interest. This implies no upside to the borrower from a reorganization, which as a consequence will require some positive payoff amount contingent on a high extended loan payoff in order to ensure participation in the reorganization. We posit that full bargaining power rests with the lender-security issuer during negotiations over costs of financial distress, implying that only a trivially small concession is required conditional on a successful reorganization outcome to assure borrower participation.

Previously we suggested that the going concern value of the asset given a negative sector-level shock was  $A^B$ . This value presumed incumbent management operating under non-distressed conditions. In the case of a loan restructuring under conditions of financial and economic distress, we presume that incumbent management teams operating under stressful conditions respond idiosyncratically to a reorganization. In particular, let the probability of a high-value extension state be  $\omega$ ,  $\omega \in (0,1)$ , which depends on the idiosyncratic characteristics of the incumbent managers. From the uninformed senior securityholder's perspective (as well as that of other outsiders),  $\omega$  is a continuous random variable defined on the interval  $(0,1)$ . This probability is, in contrast, known to both the incumbent owner-manager of the collateral asset as well as the junior securityholder (the

original lender), where  $\omega$  is revealed to insiders at  $t=1$  prior to the liquidation-reorganization decision. The realized  $\omega$  cannot be communicated credibly by the insiders to the senior securityholder, and is non-verifiable.

The following lemma establishes the efficient liquidation-reorganization decision outcome that results when the original informed lender retains sole ownership of the loan.

*Lemma 2: The critical successful reorganization probability,  $\omega^*$ , that establishes whether liquidation v. reorganization is efficient is  $\omega^* = \frac{x-\gamma}{2x}$ .*

*Proof: The critical probability of success in reorganization that equates the expected payoff from reorganization with the sure payoff from liquidation is  $\omega(A^B+x)+(1-\omega)(A^B-x)=A^B-\gamma$ . This produces the stated result, where  $\omega < \omega^*$  implies liquidation and  $\omega > \omega^*$  results in reorganization. QED*

The boundary probability,  $\omega^* = \frac{x-\gamma}{2x}$ , is seen to be increasing in  $x$ , which measures the payoff risk in reorganization, and decreasing in  $\gamma$ , the firesale discount factor associated with immediate liquidation. Also note that  $\omega^* = \frac{x-\gamma}{2x}$ , is such that  $\omega^* < \frac{1}{2}$ . Given a symmetric distribution for  $\omega$  on the (0,1) interval,  $\omega^* < \frac{1}{2}$  indicates a preference favoring reorganization over liquidation on average. This follows since, in principal, given the firesale costs associated with liquidating the asset under difficult industry conditions, playing for time with a sufficiently competent management team in place makes good sense. That said, however, given full information regarding incumbent asset management quality, efficiency dictates specific circumstances for booting out current management through liquidation – that being when the likelihood of a successful debt restructuring outcome is sufficiently low.

This lemma isolates the source of the information frictions associated with whole loan liquidation. Not only is the wholeloan unsafe (risky), it is also informationally sensitive. Information sensitivity is defined here in a specific way, following from the fact that the outsider does not know the true quality of incumbent management in a reorganization and therefore is not well positioned to make informed liquidation-reorganization decisions. Crucially, knowledge of the true  $\omega$  associated with a reorganization eliminates information sensitivity—but it does not eliminate risk associated with investment in the whole loan—since outsiders are not otherwise on the same information playing field as insiders. Safety, and thus elimination of investment risk, can be accomplished through tranching, but cannot be assured by optimized governance alone.

Now, let us return to the optimal security-governance design problem. Conditional on borrower default at  $t=1$ , tranching distorts incentives of the senior and junior securityholders—in diametrically opposing directions—as related to the liquidation versus reorganization decision. Neither class of securityholder, including the informed residual claimant, has the proper incentives to make efficient liquidation-reorganization decisions at the previously established senior security face value of  $A^B - \gamma$ . Moreover, given that reorganization is a potential outcome of borrower default, the senior securityholder requires a decrease in the security’s face value to ensure a “safe” investment. Lemma 3 below states the results.

*Lemma 3: Given the senior-subordinate security structure previously described: i) For any face value in excess of  $A^B - x$  the senior securityholder always prefers liquidation over reorganization; ii) For any senior security face value in excess of  $A^B - x$ , the junior securityholder excessively reorganizes relative to the efficient level of reorganization; iii) To retain safety of investment, and given that reorganization cannot be ruled out given borrower default at  $t=1$ , the senior securityholder will require a face value not greater than  $A^B - x$ ;*

*Proof: i) If senior security face value exceeds  $A^B - x$  the senior security always prefers liquidation with a payoff of  $A^B - \gamma$ , since that payoff will eliminate any risk of investment loss. ii) For any senior security face value greater than or equal to  $A^B - \gamma$ , the junior securityholder receives nothing in liquidation, so will always prefer reorganization. Now consider senior security face value of  $A^B - \gamma$ ,  $\gamma \leq y < x$ . The junior securityholder will prefer reorganization over liquidation whenever  $\omega$  is such that its expected payoff from reorganization exceeds its sure payoff from liquidation. The sure payoff is  $y - \gamma$ , so preference for reorganization occurs when  $\omega(x + y) > y - \gamma$ , or whenever  $\omega > \frac{y - \gamma}{x + y}$ . Given that  $y$  ranges between  $\gamma$  and  $x$ , it is clear that reorganization occurs for  $\omega$ 's that are less than  $\omega^* = \frac{x - \gamma}{2x}$ , implying the potential for excess reorganization relative to the efficient level of reorganization. iii) Follows directly from lemma 1. QED*

The first two results provide foundation for subsequent analysis that tackles optimal security structuring problem through incentive compatible governance design.

The third result in lemma 3 establishes that “safe” senior securityholder participation dictates a reduction of senior security face value to eliminate additional risk that accompanies reorganization in financial distress. While it is true that a controlling junior securityholder will efficiently liquidate-reorganize when senior security face value equals  $A^B - x$ , liquidation proceeds from senior security sale are reduced by  $x - \gamma$  relative that achieved when liquidation in default is assured (i.e., when the senior security holds governance control rights). The second result of the lemma shows that reorganization is always favored by the junior securityholder when senior security face value equals  $A^B - \gamma$ , which cuts in the diametrically opposite direction. The central question of this paper now is how to achieve the desired liquidation proceeds of  $A^B - \gamma$  while also generating efficient

liquidation-reorganization decision outcomes that in combination maximize combined senior security liquidation-junior security retention value for the seller.

## **II.B. Necessary Conditions and Foundational Results**

We will now present a series of statements and results that provide a foundation for achieving the optimal securities-governance design, and the necessary conditions required to generate the desired outcome.

We begin with a formal statement of the necessary conditions required to achieve securities-governance design optimality.

*Necessary Conditions to Simultaneously Maximize Senior Security Liquidation Proceeds and Efficiency in Distressed Loan Resolution Decisions: The optimal mechanism design is one that maximizes liquidation proceeds for the seller from a senior security sale while also achieving efficiency with respect to liquidation-reorganization decisions. The specific necessary conditions are: i) The informed junior securityholder controls the liquidation-reorganization decision; ii) The borrower has incentives to participate in a reorganization; iii) The junior securityholder's liquidation-reorganization decision is incentive compatible; iv) Payoffs required to ensure incentive compatibility of the junior securityholder can be fully funded; v) The senior securityholder participates (invests) knowing its investment is "safe"; and vi) The integrity of the optimal mechanism design is assured.*

It is important to stress that the collective satisfaction of these necessary conditions are *not* sufficient to establish first-best. That is, although the necessary conditions are collectively implementable, by themselves they do not collectively imply optimality. It turns out that the "safe" investment requirement is the complicating factor, which in turn affects efficiency in the liquidation-reorganization decision.

The following series of propositions lay out the logical structure of our argument. First note that the second condition of borrower participation was previously addressed by establishing a trivially small payoff to a successful reorganization outcome based on lender-junior securityholder possessing full bargaining power. The sixth condition of integrity will be assumed, and can be achieved by the seller through legally binding representations and warranties made during the security issuance process (say, in a securities prospectus). We will nevertheless comment on this integrity condition when we address the funding liquidity condition iv).

Now, consider first the issue of optimal control in security governance.

*Proposition 1: The junior securityholder is optimally vested with control over liquidation-reorganization decisions.*

*Proof:* Follows directly from lemmas 2 and 3. Conditional on default, the senior securityholder does not possess the requisite information to know the borrower's probability of success from a reorganization, whereas the junior securityholder does. This means the junior securityholder is capable of achieving an efficient liquidation-reorganization decision outcome and therefore should possess control rights. QED

We note that, from lemma 3 part ii), vesting control with the junior securityholder is not sufficient to achieve an efficient allocation conditional on a senior security face value that exceeds the “safe” value of  $A^B - x$ . In particular, as observed earlier, without additional control mechanisms the junior securityholder will always reorganize when senior security face value equals the desired level of  $A^B - \gamma$ .

Incentive compatibility in security governance, the third necessary condition noted previously, directly addresses the excess reorganization incentives of the controlling junior securityholder at the maximum possible level of senior security issuance proceeds. Incentive compatibility is achieved as follows.

*Proposition 2:* Given junior securityholder control over the liquidation-reorganization decision, and assuming a maximum senior security face value of  $A^B - \gamma$ , a payoff made by the junior securityholder to the senior securityholder of  $i^* = (x + \gamma)\omega^* = \frac{x^2 - \gamma^2}{2x}$  conditional on reorganization will result in efficient liquidation-reorganization decision outcomes.

*Proof:* With a senior security face value of  $A^B - \gamma$ , the payoff to the junior security from reorganization (loan extension) in a good continuation realization is  $x + \gamma$ . The payoff is zero from a bad realization. Furthermore, as established in lemma 2, a reorganization is worth more than immediate liquidation whenever  $\omega > \frac{x - \gamma}{2x} = \omega^*$ . This implies the expected payoff to the junior securityholder as residual claimant from reorganization is at least  $(x + \gamma)\omega^* = \frac{x^2 - \gamma^2}{2x}$ . Thus, requiring the junior securityholder to fund a payoff to senior securityholders of  $i^* = \frac{x^2 - \gamma^2}{2x}$  will ensure the junior securityholder only reorganizes when  $\omega > \omega^*$ , thus assuring efficiency in the resolution of financial distress. QED

(4)

Low-quality borrowers with  $\omega < \omega^*$  will be liquidated with a payoff of  $A^B - \gamma$ , which supports a senior security face value of the same amount.

Proposition 2 raises two critical follow-up questions. First, given the incentive compatible payoff stated in the proposition, is that payoff plus the payoff from a bad reorganization outcome sufficient to meet the “safe” security investment threshold of  $A^B - \gamma$ ? If it is, then payoffs to the senior securityholder are such that they at

least equal the face value under all states of the world, thus satisfying the “safe” investment requirement. It turns out that the answer to the question is *no*, as formalized in the following corollary.

*Corollary 1 to Proposition 2: The payoff to the senior securityholder from a failed reorganization decision plus the incentive compatible (IC) payoff made by the junior securityholder to senior securityholder is less than  $A^B - \gamma$ , which fails to support the “safe” investment requirement of the risk of any loss under any state of the world.*

*Proof: The security securityholder’s payoff from a failed reorganization plus the IC payoff equals  $A^B - x + \frac{x^2 - \gamma^2}{2x}$ . It is straightforward to show that this quantity is less than  $A^B - \gamma$  when  $\gamma < x$  as previously assumed. QED*

In other words, implementation with the requirement of senior security safety is infeasible given the current construct of a single asset SPV pool.

This shortfall immediately raises the issue of *what* IC payoff amount originating from the junior securityholder, paid to the senior securityholder conditional on reorganization, is sufficient to generate a combined payoff of  $A^B - \gamma$  associated with a failed reorganization outcome. Given a senior security payoff  $A^B - x$  from a failed outcome, it is clear that the required IC transfer payment amount equals  $x - \gamma$ . This in turn begs the question of what the implied IC liquidation-reorganization probability cutoff is, which we answer in the following corollary.

*Corollary 2 to Proposition 2: Given a senior security face value of  $A^B - \gamma$ , and the “full funding” transfer payment of  $x - \gamma$  that is required contingent on a reorganization decision, the junior securityholder will only reorganize if  $\omega \geq \frac{x - \gamma}{x + \gamma}$ , with  $\bar{\omega} = \frac{x - \gamma}{x + \gamma} > \omega^*$ .*

*Proof: Straightforward. Follows from a payoff to the junior securityholder of  $x + \gamma$  given successful reorganization. Showing  $\bar{\omega} = \frac{x - \gamma}{x + \gamma} > \omega^*$  is trivial. QED*

Because  $\bar{\omega} > \omega^*$ , excess liquidation occurs, which follows because of the higher IC transfer payment required with reorganization. Thus, to achieve maximum proceeds with senior securityholders that insist on complete safety of investment, a “high” IC transfer payment is required that causes excessive liquidation to occur.

Given our focus on the time  $t=0$  liquidity demand of the seller, it is relevant to ask whether the junior securityholder (the seller) generates enough additional liquidity through IC mechanism design to fund the contingent transfer payment of either  $\omega^*$  or  $\bar{\omega}$ . This in fact corresponds to the fourth necessary condition identified above. It turns out the answer is *yes*, as stated in the following corollary.

*Proposition 3: Relative to a senior security face value of  $A^B - x$ , achieving a senior security face value of  $A^B - \gamma$  generates enough incremental liquidity at issuance for the junior securityholder to fund a contingent transfer payment of up to  $\bar{\omega}(x + \gamma)$ .*

*Proof: Additional liquidity generated at issuance is  $x - \gamma$ , which exactly equals the transfer payment when the cutoff probability value equals  $\bar{\omega}$ . The quantity  $x - \gamma$  is seen to exceed  $\omega^*(x + \gamma)$ , the efficient IC transfer payment amount. QED*

The incremental proceeds are thus more than enough to fund  $\omega^*$ , assuming it was implementable. This, along with a set-aside requirement, helps ensure the integrity of the security-governance mechanism design required in the sixth necessary condition, as it provides comfort for senior securityholder that the IC payment, should it be required, can be fully funded in relation to structuring the absolutely safe senior security with face value of  $A^B - \gamma$ . We note that other substitute funding mechanisms could be structured to ensure the contingent payment, including recourse to the borrower in reorganization should the borrower be sufficiently liquid and compensated appropriately given a successful reorganization outcome. Another possible structure would be delegating liquidation-reorganization decisions (and payoffs conditional on reorganization) to a sufficiently liquid agent (in practice known as a special servicer) that follows liquidation-reorganization decision directives of the junior securityholder.

## **II.C. Achieving the Optimal Securities-Governance Design**

Although necessity of each relevant condition has been shown, the ideal securities-governance is not yet implementable. This is because the efficient IC transfer payment is insufficient to render the senior security riskless conditional on an unsuccessful reorganization outcome. We will now examine two conditions under which implementation is feasible.

One solution is to relax the conditions under which “safe” investment occurs. Currently “safe” senior security investment requires zero risk of being repaid anything less than the security’s face value under state of the world. This requirement implies that the senior security is also informationally insensitive.

We now relax the absolute investment safety requirement, supposing that a clientele of senior security investors exists that only requires that the senior security is informationally insensitive. Thus we are making a

critical distinction between completely safe investment and information insensitive investment, with the following definition

*Definition: Informationally insensitive investment means that, given junior securityholder control over security governance and for a given incentive compatible transfer payment conditional on borrower default and reorganization, there are no cases where, at the  $t=1$  time of the liquidation-reorganization decision, there is an expected loss of senior security face value inclusive of the transfer payment.*

This seems to be a reasonable and realistic investment requirement, where senior securityholders are observed to accept some small risk of loss in which the risk is immunized against information-based agency effects. The senior security is informationally insensitive because a properly determined IC transfer payment ensures no trade-based informational disadvantage relative the informed junior securityholder that controls the liquidation-reorganization decision. This definition also seems generally consistent with that of Gorton (2009), who emphasizes *ex post* shocks which cause a security that was previously deemed to be informationally insensitive (having a low probability of credit loss) to shift towards being information-sensitive, where the concern is trading with an informed counter-party.

This distinction between absolute safety of investment and information insensitivity is important but not completely understood. Complete safety of investment implies information insensitivity, but not vice versa. Information insensitivity in our case means that a security is sufficiently safe *ex ante* so as not to require information production for trade to occur. When the potential for *ex post* information sensitivity is anticipated *ex ante*, mechanisms can be implemented in advance to align incentives after the fact. Successful implementation does not completely eliminate the possibility of investment losses, but by eliminating adverse effects of *ex post* informational disadvantage, *ex ante* trade can occur *as if* a level playing field exists between the informed seller and uninformed buyer

We will take up this issue again in the empirical section of the paper, but at this point it is worth recognizing the existence of security designs that distinguished between super-safe AAA-rated structured securities and run-of-the-mill AAA-rated securities whose face values were determined right at the AAA- and AA-rating margin. Investing at this margin introduces downgrade risk, not to mention a non-trivial probability of loss of principal. But, as we will discuss in detail in the empirical section of the paper, certain offsetting

factors seemed to be built into the structure that had direct analogies to the IC transfer payments we analyze in this theory section.

The following proposition establishes that the previously established IC payment at the efficient liquidation-reorganization value satisfies the information insensitivity requirement.

*Proposition 4: Suppose that at a senior security with face value of  $A^B - \gamma$  is offered to senior securityholders that requires only information insensitivity in investment. Given junior securityholder control in governance, an IC transfer payment based on the efficient reorganization success probability of  $\omega^*$  ensures information insensitivity of the senior security and thus generates maximum liquidation proceeds of  $A^B - \gamma$ .*

*Proof: State outcomes that result in loan repayment and liquidation conditional on default generate a payoff of  $A^B - \gamma$  to the senior securityholder. What remains is to show the minimum expected payoff conditional on borrower default and reorganization is at least  $A^B - \gamma$ . Given an IC transfer payment of  $\omega^*(x + \gamma)$ , liquidation-reorganization decisions are efficient. Consequently, the minimum expected payoff to the senior securityholder inclusive of the IC transfer payment in reorganization is  $\omega^*[A^B - \gamma] + (1 - \omega^*)[A^B - x] + \omega^*(x + \gamma)$ . Using  $\omega^*$  as established in lemma 2, the minimum expected payoff exactly equals  $A^B - \gamma$ , thus ensuring information insensitivity of senior security investment. QED*

Note that information insensitivity cannot be achieved with a whole loan sale, since the seller no longer has a stake and has no ability to credibly communicate the true  $\omega$  at the  $t=0$  time of sale. Hence a senior-subordinate tranche structure with junior securityholder control is necessary to ensure efficiency.

The second method to achieve an efficient allocation is to rely on the law of large numbers and increase the size of the liquidating pool of loans. In this case, rather than the seller offering one loan of size  $L$ , assume a pool of  $N$  identical loans of size  $L$  with liquidation motives of the seller applying to the entire  $N$ -loan portfolio. All loans are collateralized by assets from the same industry, and all are therefore subject to the same industry level shock that produces an immediate liquidation discount of  $\gamma$  conditional on borrower default at  $t=1$ . Also, similar to the baseline  $N=1$  model structure, assume that incumbent management's ability to cope with reorganization in financial distress is independently determined (i.e., the  $\omega_i$ 's are determined by independent draws with replacement) from a common *pdf* defined on the continuous interval  $(0,1)$ . The informed seller/junior securityholder can observe all draws made from the distribution, but outsiders cannot. Other necessary conditions are as previously described and determined.

The following lemma establishes that, for any pool of size  $N$  as defined above, given a negative industry shock at time  $t=1$  that results in borrower default, *ex post* efficiency dictates applying the same IC transfer

payment and decision rule as previously established in the  $N=1$  case to all  $N$  defaulted loans, doing so on a loan-by-loan basis.

*Lemma 4: Control over liquidation-reorganization decisions with defaulted loans optimally resides with the junior securityholder. After experiencing a common negative shock and observing each draw,  $\omega_i$ ,  $i \in \{1, \dots, N\}$ , the junior securityholder transfers  $t = t^*$  to the senior securityholder with each reorganized loan. Incentive compatibility results in liquidating loans for which  $\omega_i < \omega^*$  and reorganizing loans for which  $\omega_i \geq \omega^*$ .*

*Proof: By contradiction. Because the  $\omega_i$ 's are drawn independently with replacement, any deviation from the stated strategy with an individual loan is sub-optimal, resulting in an outcome that is collectively sub-optimal. QED*

The result is intuitive, where independence ensures no spillover effects going from one management team to another.

For any finite  $N$ , by following the stated strategy there exists a positive probability that the senior securityholder will experience a loss of principal. That probability diminishes to zero, however, as the pool size grows arbitrarily large, thus ensuring that senior securityholders investment is (almost surely) “safe” at the efficient liquidation-reorganization cutoff probability,  $\omega^*$ , and at the maximum proportional senior security size,  $A^B - \gamma / L$ . The following proposition states our main result.

*Proposition 5: As  $N \rightarrow \infty$ , the optimal security-governance design is implementable when senior securityholders demand safe investment.*

*Proof: Apply the law of large numbers to the strategy stated in the lemma and then to this proposition. As  $N \rightarrow \infty$ , proportional payoffs from reorganization, inclusive of the IC transfer amount, converge to a proportional payoff amount that exceeds  $(A^B - \gamma) / L$ , thus ensuring proportional payoffs in all states of the world that are at least the proportional senior security face value amount of  $(A^B - \gamma) / L$ . QED*

Note that the relevant amounts and payoffs are now expressed as a proportion of  $L$ . This is because the total pool size,  $NL$ , the total face value of the senior security,  $N(A^B - \gamma)$ , and the cumulative IC payoffs,  $Nt^*$ , become arbitrarily large as  $N$  itself gets large, whereas the appropriate ratios remain constant.

A numerical example may prove helpful at this point. Let the asset value in a bad state  $A^B = 80$ , the liquidation discount  $\gamma = 4$ , and the variation in restructuring outcomes  $x = 8$ . The resulting maximum face value of the senior security is  $A^B - \gamma = 76$ . Payoffs to the asset in a restructuring are either  $A^B + x = 88$  or  $A^B - x = 72$ .

The breakeven probability that establishes indifference between immediate liquidation and restructuring is  $\omega^* =$

$\frac{x-\gamma}{2x} = 1/4$ , with liquidation (reorganization) occurring when the incumbent management is revealed to possess an  $\omega < 1/4$  ( $\geq 1/4$ ). The incentive compatible transfer payment made at the time of reorganization is  $t^* = (x+\gamma)\omega^* = \frac{x^2-\gamma^2}{2x} = 3$ .

Now consider the case of  $N=1$ , and for simplicity assume that, conditional on reorganization, the  $\omega$ 's are symmetrically distributed on the interval  $[1/4, 1)$ . This implies the conditional mean on this interval is  $5/8$ , which in turn implies that reorganizations are expected to be successful on average with probability  $5/8$  and fail with probability  $3/8$ . Proceeding, conditional on borrower default at time  $t=1$ , for a revealed  $\omega < 1/4$  and a required IC transfer payment of  $t^* = 3$ , the junior securityholder liquidates and sells the asset for  $76$ . For  $\omega \geq 1/4$  and  $t^* = 3$ , the junior securityholder reorganizes by extending the loan one period, where the senior securityholder's expected payoff is  $(5/8)(76) + (3/8)(72) + 3 = 77.50$ . Hence, conditional on reorganization, there is a  $3/8$  probability of being paid a total of  $75$ , which falls short of the security's face value by  $1$ . The senior security is therefore unsafe in this example, but it is informationally insensitive, since the junior securityholder only reorganizes when it is efficient to do so. Moreover, there is a  $5/8$  probability of receiving  $79$  in total, which makes the expected senior security payoff in reorganization greater than  $76$ .

From proposition 4, as  $N \rightarrow \infty$ , the probabilities stated in the  $N=1$  case become realized proportions and payoffs become certainties. That is, as  $N \rightarrow \infty$ ,  $1/4$  of all loans are liquidated, while the remainder are reorganized. Of those that are reorganized,  $5/8$  experience a successful reorganization outcome and  $3/8$  do not. With  $t^*=3$  paid on each loan that is reorganized, the certain payoff conditional on reorganization is  $77.50$  on a per loan basis. Consequently, in all states of nature the senior securityholder receives at least  $76$  per loan, with certainty, making the investment "safe". Said slightly differently, as pool size increases the senior security becomes increasingly safe, and in the limit is completely safe. This suggests that larger pools attract senior security investor clienteles that are interested in safety, while smaller pools attract senior security investor clienteles that are satisfied with information insensitivity as defined herein.

In summary, in this subsection we show that the optimal security and governance design is implementable by forming large diversified asset pools with allocation of *ex post* decision rights given to junior securityholders in conjunction with the appropriately determined IC payoff amount paid by the junior

securityholder to the senior securityholder contingent on borrower default and loan reorganization.

Implementation in the case of  $N \rightarrow \infty$  is analogous to Diamond's (1984) famous result on the efficiency of loan monitoring by large intermediaries. We extend DeMarzo (2005) in our consideration of security governance, and our formal proof of the allocation of decision rights to well-informed junior securityholders confirms the conjecture of Riddiough (1997) in his analysis of optimal security governance.

### III. Taking the Model to the Data

#### III.A. Empirical Implications and Model Extension

In this section we outline empirical implications of the model that we can then take to the data. To start, recall that our theory distinguishes between two tranches – a low- or no-risk senior security that is sold to outsiders and a junior security that is retained by the seller. As a threshold empirical implication, we observe that our model predicts the existence of two possible senior security investor clienteles: those that demand “safe” securities and those that are willing to accept some incremental credit risks as long as the security is designed to be informationally insensitive. As noted earlier, security size may also allow us to distinguish between the two types of securityholders.

Given this distinction, our model can be easily extended to recognize the existence of three tranches: “super-senior” securities that are immunized against the loss of principal under any conceivable state of the world, low-risk informationally insensitive securities, and higher-risk junior securities. The distinction between senior classes of securities that differ by their demand for safe versus informationally insensitive senior securities is to our knowledge new and novel.

Much of the empirical testing will focus on comparative static predictions of the model. We will specifically analyze model predictions associated with the incentive compatible payoff made to the senior

securityholder. Recall the efficient IC transfer payment was calculated as  $t^* = (x+\gamma)\omega^* = \frac{x^2 - \gamma^2}{2x}$ . Comparative

statics for  $t^*$  are stated (without proof) in the following corollary.

Corollary to Proposition 2:  $\frac{\partial t^*}{\partial \gamma} < 0$  and  $\frac{\partial t^*}{\partial x} > 0$ .

The intuition underlying these relations is important for the empirical analysis to follow. First, suppose there is a negative shock to collateral-sector fundamentals that causes an increase in  $\gamma$ . As the discounted payoff to immediate liquidation,  $\gamma$ , increases, the efficient IC payoff decreases. This is because a greater liquidation discount decreases the critical reorganization cutoff probability, as securityholders acknowledge deteriorated industry conditions merit increased patience in addressing borrower financial distress. On the other hand, an increase to payoff risk in reorganization,  $x$ , makes liquidation a relatively more attractive option to senior securityholders. The reorganization cutoff probability consequently increases as senior securityholders become wary of downside reorganization risk. Junior securityholders, whose payoff function is convex in reorganization, are willing to pay the increased IC payoff amount, since the increased risk also increases their payoff  $(x+\gamma)$  from a successful reorganization outcome.

We would also like to develop comparative statics for  $t^*$  as it depends on pool size,  $N$ . In the modeling section we formally considered the cases for  $N=1$  and  $N=\infty$ . Recall that in the  $N=1$  case, safety of senior security investment could be assured with a reorganization cutoff probability of  $\bar{\omega} = \frac{x-\gamma}{x+\gamma}$ , with  $\bar{t} = (x + \gamma)\bar{\omega} = x-\gamma$ . These quantities exceed  $\omega^*$  and  $t^*$ , respectively, where proposition 5 shows that  $\omega^*$  and  $t^*$  obtain when  $N=\infty$ . This rather coarse ( $N=1$  to  $N=\infty$ ) comparison implies that  $\frac{\partial t^*}{\partial N} < 0$ . The intuition for the result is, when safety of investment is required for senior security investor participation, at a senior security face value of  $A^B-\gamma$  the risk of a loss of investment principle due to failed reorganizations diminishes with larger pool sizes. This in turn implies the reorganization cutoff probability—and therefore the IC payoff amount—is reduced accordingly.

But this rather coarse comparative static analysis raises the issue of whether the comparative statics with respect to  $\gamma$  and  $x$  are robust to the effects of pool size. In response, consider the following reduced form expression for  $t(N)$ , where

$$t(N) = \frac{x-\gamma}{2x} \left[ x + \gamma + \frac{x-\gamma}{\sqrt{N}} \right] \quad (1)$$

In this formulation  $t(N)$  is seen to be a weighted sum of  $t(1) = \bar{t}$  and  $t(\infty) = t^*$ , with weighting factor  $\frac{1}{\sqrt{N}}$ . With this formulation it is straightforward to show that the original comparative statics with respect to  $\gamma$  and  $x$  hold, and that  $\frac{\partial t(N)}{\partial N} < 0$ .

Observe that the above comparative static with respect to  $N$  applies to a “safe” senior security investor clientele. In the case of a informationally insensitive senior investor clientele the model predicts that  $t^*$  obtains for all  $N$ , and therefore that the IC payoff is invariant to  $N$ . Consequently, it is an empirical question as to how  $\frac{\partial t(N)}{\partial N}$  will shake out, where, as noted previously, there could be a shift in the composition of senior security investors from informationally insensitive to safe as pool size increases.

To this point we have placed no structure on the model in terms of how  $\gamma$  and  $x$  might interact with or depend on one another. For given parameter values as of a particular point in time, it is likely that a shock to collateral-sector fundamentals will trigger changes to both  $\gamma$  (an immediate effect) and  $x$  (affecting payoffs in the future), where the shock hits  $\gamma$  directly with effects that ripple through to cause adjustments to  $x$ . A further complication is that any changes to  $x$  as the result of a fundamental collateral-sector shock are likely to be asymmetric, where a negative shock implies larger decreases in failed reorganization payoffs and smaller increases in payoffs to a successful reorganization.

With these structural effects in mind, in bringing our model to the data we extend our baseline model as follows. Let  $A^B - x_0$  and  $A^B + x_1$ ,  $x_0, x_1 > 0$ , represent payoffs to a failed versus successful reorganization, respectively. To streamline the analysis we will require

$$x_0 + x_1 = c \tag{2}$$

where  $c$  is a positive constant with  $x_0 > \gamma$  as before. This restriction implies that, although fundamental shock effects on  $x$  are asymmetric, the difference between successful versus failed reorganization payoffs remains constant.

We further impose the structural relation,

$$x_0 = e + d\gamma \tag{3}$$

This relation implies that fundamental collateral-sector shocks propagate first through  $\gamma$  and then through  $x$ , with  $x$  a linear function of  $\gamma$ . The parameter  $e > 0$  measures the baseline reorganization payoff risk when there is no liquidation discount, and the parameter  $d \geq 0$  indicates the sensitivity of  $x_0$  to increases in the liquidation discount,  $\gamma$ . The sensitivity parameter  $d$  will typically be less than 1 in recognition that the effects of negative

shocks to fundamentals soften (revert to steady-state values) over time. A parameter value  $d > 1$  indicates a strong, amplified negative reaction of  $x$  to a change in  $\gamma$ .

Along with the restriction that payoffs from reorganization are symmetric around  $A^B$  when  $\gamma=0$ , equations (2) and (3) imply that  $x_I = e - d\gamma$  and that  $c=2e$ . This added model structure further implies the following relationships: i)  $x_I > 0 \Rightarrow \gamma < \frac{e}{d}$ ; and ii)  $\gamma < x_0 \Rightarrow \gamma < \frac{e}{1-d}$  for  $d < 1$ .

With these modifications to the baseline model, all other baseline model relationships carry through with only slight modifications. Basic results remain as before. What does change is that the focus of the comparative static analysis is on  $\gamma$ , since  $x$  now depends directly on  $\gamma$ . Now, by taking the structural relations articulated in equations (2) and (3), we can rewrite the efficient IC payoff amount,  $\iota^*$ , as well as  $\bar{\iota}$ , as follows:

$$\iota^* = \frac{1}{c} [(e + \gamma(d - 1))(e - \gamma(d - 1))] \quad (4a)$$

$$\bar{\iota} = e + \gamma(d - 1) \quad (4b)$$

With (4a) and (4b) above, equation (1) can also be rewritten as follows:

$$\iota^*(N) = \iota^{**} + \bar{\iota} \left[ \frac{e + \gamma(d - 1)}{c\sqrt{N}} \right] \quad (4c)$$

We are now in a position to consider the total effect that an exogenous shock to  $\gamma$  has on the various IC payoff amounts (as seen in (4c), the comparative static of  $i(N)$  with respect to  $N$  remains negative). This total effect accounts not only for  $\gamma$  in isolation, but also for how  $x$  responds to the change in  $\gamma$  as reflected through the sensitivity parameter  $d$  stated in equation (3). The following proposition states (without proof) the comparative statics of interest:

*Proposition 6:*  $\frac{\partial \iota^*}{\partial \gamma} < 0$  for all  $d$ ;  $\frac{\partial \bar{\iota}}{\partial \gamma} < (>)0$  for  $d < (>)1$ ;  $\frac{\partial \iota(N)}{\partial \gamma} < (>)0$  for  $d < 1$  and for  $d > 1$  with  $N$  large (for  $d > 1$  with  $N$  small).

The proposition states that the relation between the IC payoff and immediate liquidation discount is generally negative. The cleanest relation is with the efficient IC payoff amount of  $\iota^*$ , which always declines in reaction to a negative fundamental-collateral shock that increases  $\gamma$ . This relation even holds for  $d > 1$ , which is the case when  $x$  has an amplified reaction to the initial shock. In the case of  $\bar{\iota}$ , which is the required payoff amount to ensure safe investment in the case of  $N=1$ , the negative comparative static obtains when  $d < 1$ , with the relation

flipping when  $d > 1$ . With a small  $N$  and amplified decreases in  $x_0$  resulting from a reorganization ( $d > 1$ ), senior security investors that insist on safety of investment require an increase in the IC payoff amount—this even though firesale discounts from immediate liquidation also increase. Finally, in the case of  $\iota(N)$ , given that it is a weighted sum of  $\iota^*$  and  $\bar{\iota}$ , with weighting factor  $\frac{1}{\sqrt{N}}$ , the comparative static results reflect the weighting. For  $d < 1$ , or for  $d > 1$  given a large asset pool or a senior security offering that attracts informationally insensitive (as opposed to safe) investors, the comparative static is negative. Only in the case of  $d > 1$  and small asset pools that attract senior security investors that demand full safety of investment does the comparative static relation flip to become positive.

### III.B. Incentive Compatible (IC) Transfer Payment Measure

For the empirical analysis we focus on the *ex ante* (at-issuance) predictions of our model as opposed to assessing *ex post* (default resolution) realizations. This *ex ante* approach allows to assess the revealed preferences of the issuer and investors conditional on security structure, as well as current and expected market conditions. An *ex post* analysis in our case is less compelling due to the sheer magnitude and unanticipated characteristics of the realized systemic shocks that occurred during and after the financial crisis, which stressed servicing operations and caused large revisions to prior expectations.

To test the *ex ante* (at-issuance) predictions of our theory, our first step is to identify an empirical measure of the IC transfer payment. Recall that this transfer payment is meant to ameliorate concerns of senior securityholders that controlling junior securityholders will excessively reorganize defaulted loans—a delay-inducing moral hazard that exposes senior bondholders to additional downside risks. We also know that in the model the IC payoff made by the junior to senior securityholder is contingent on borrower default and subsequent reorganization.<sup>6</sup> Another way to robustly characterize the IC payoff is to say it is required as long as the loan is alive, and terminates upon termination of the loan through maturity, payoff or liquidation. In this sense, the IC payment can be characterized as a *continuation* payment—an incremental interest payment above the baseline

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<sup>6</sup> Reorganization means extending the loan one period in the hope of increasing liquidation proceeds relative to the immediate liquidation payoff.

senior security coupon interest payment, where the baseline payment compensates the investor for other more standard investment risks.

Importantly, total coupon interest payments promised to both senior and junior securities are constrained by the total amount of interest received from the underlying mortgage loans, as summarized by the weighted average coupon (WAC). The basic idea, then, is that enough interest has to be paid on the pooled mortgages to cover the promised coupon interest payments on the securities. When this constraint binds, any excessive interest coupon payments made to senior bondholders come at the expense of payments that could have otherwise been made to junior bondholders. In this case, entirely consistent with the logic of our model, excess coupon interest paid to senior bondholders is a form of a payment subsidy coming from the junior bondholders.<sup>7,8</sup>

AAA-rated CMBS are designed to price close to par. For the at-the-margin AAA-rated securities, at issuance there is a small amount of credit risk, cash flow timing risk and liquidity risk that are priced by purchasers. Given a “close-to-par” pricing policy, these risks increase the required coupon rate above the equivalent-duration risk-free rate. All of these risks are anticipated (along with other risks and costs to securitization), and are priced into the originated mortgages that underly the CMBS asset pool. Coupon rates on the underlying mortgages are therefore more than sufficient to compensate AAA-rated securityholders for their investment risks. For our empirical analysis we will assume that, except for addressing IC transfer payment considerations, issuers are consistent in their at-the-margin AAA-rated security pricing policies when determining a baseline issuance price (coupon rate) relative to par, implying any increment above (or below) the baseline coupon rate is due to IC transfer payment considerations. Later in the empirical analysis we address the validity of this pricing assumption.

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<sup>7</sup> We don't discuss the junior security payment in this paper. But we note that any excessive interest coupon payments made to senior bondholders come at the expense of interest coupon payments made to junior securities, causing the latter to be sold at increasing discounts to par due to the constraint on allocating total pooled mortgage interest payments across the entire capital structure.

<sup>8</sup> The subsidy is not trivial given the disproportionate size of the senior securities. For example, suppose that the senior securities comprise 85 percent of the asset pool, and are paid a 10 basis point premium in the “par” coupon interest (yield) required, and as a result sell at a premium to par. With the junior bondholders representing 15 percent of the asset pool, payments to those bondholders must be decreased by over 50 basis points in order to fund the subsidy to senior bondholders.

### III.C. Immediate Liquidation Discount Measures

To empirically test comparative static model predictions we would like to identify variables that provide good and credible proxies for the immediate liquidation discount,  $\gamma$ . We will be less focused on locating independent proxies for  $x$ , the risk associated with reorganization, as in the extended model we show that this risk can be expressed as a direct function of industry market conditions conditions as channeled through the immediate liquidation discount,  $\gamma$ .

**Proportion of Hotel Properties in the Asset Pool (Negative Sign):** Of all property types that collateralized loans during our sample period, hotel is the most management intensive and specific. This implies that defaulted loans collateralized by hotel experience greater liquidation discounts than other property types such as apartment and office property. At the same time, all else equal, payoff risk from reorganization does not differ substantially from other property types, implying low size and sensitivity effects associated with  $x$  as a function of  $\gamma$ . Altogether the relation between the proportion of hotel properties collateralizing loans in the asset pool and relative IC payoff is predicted to be negative, since liquidation is known to be costly with hotel property, thus alleviating concern of inefficient reorganization by controlling junior securityholders.

**Average Property Size of Collateral Assets in the Asset Pool (Negative Sign):** A similar logic applies to property size. Larger properties are thought to be more complex and thus demand greater management expertise, making liquidation relatively more expensive due to a thinner pool of qualified managers. As a result a negative relationship between average property size and relative IC payoff is predicted.

**Year 2007 (Negative Sign):** Market conditions deteriorated markedly in 2007 relative to the prior three years. In line with our extended model, this implies meaningful upward revisions in the liquidation discounts taken from defaulted loans, with accompanying decreases in payoffs from failed reorganization outcomes. The increase in discounts from immediate liquidation likely exceed markdowns in reorganization payoffs to occur further out in the future (see Brown, Ciochetti and Riddiough (2006) for additional background). This implies that IC payoffs decrease in year 2007 due to the moderating effects of high liquidation discounts relative to senior bondholder concerns over excess reorganization incentives of controlling junior bondholders.

### III.D. Asset Pool Diversification Measures

**Number of Assets in the Pool (Negative Sign):** We are also interested in measuring asset pool diversification effects as expressed through  $N$  in the model. Comparative statics indicate that, when senior CMBS investor clienteles include “safe” investors and senior security payoffs become increasingly predictable with better asset pool diversification, the relative IC payoff declines in  $N$ . We measure  $N$  empirically with the number of assets (properties) collateralizing the underlying asset pool.

### III.E. Ex-post Security Governance Measures

**Master Servicer = Special Servicer (Negative Sign):** In the mortgage-backed security market, security governance is particularly important. After origination, a master servicer oversees the trust (SPV), working to ensure the timely payment of interest and principal to investors. In the pooling and servicing agreements, the master servicer is instructed to look after the interests of the trust as a whole, implying no direct conflict with regard to making liquidation versus reorganization decisions with defaulted loans. When a loan defaults, however, the loan is transferred to a special servicer that has expertise in loan renegotiation and maximizing proceeds from default. During our sample period, the pooling and servicing agreements (which codify the security governance rules, among other things) granted decision rights to junior securityholders based on their designation as a “controlling class.” Junior securityholders were also allowed to own the special servicer.<sup>9</sup>

As argued by Ambrose et.al. (2015), aligning the master servicer and special servicer can increase the effectiveness of security governance, since the master servicer works on behalf of the entire trust. There are observations in the data in which the master servicer and special servicer are the same entity. We would expect this situation to reduce concerns of senior bondholders regarding junior bondholder incentives to excessively reorganize default loans, leading to a prediction that the IC transfer payment is lower when the master servicer and special servicer are the same entity.

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<sup>9</sup> In this market the junior securities were either held by the issuers or sold to third parties that had extensive experience and expertise in not only structured fixed income investment but also commercial property mortgage lending and collateral analysis. This is in contrast to senior securityholders, who were typically dispersed owners that did not possess significant experience or particular expertise in commercial real estate, but who did recognize the potential existence of conflicts in the security’s governance structure.

### **III.F. Control Variables**

Several prominent control variables are included in the specification which do not have clear comparative static implications with respect to the model. More specifically, the identified control variables may have effects on credit and liquidity risks of senior security investment. They are consequently included so that we can be more confident in isolating security pricing effects that are our primary variables of interest. These control variables include senior security life (duration risk), senior security size (liquidity risk), weighted average LTV (credit risk), weighted average DSC (credit risk), and subordination level (omitted credit risks, possible correlation with variables of interest). The particular role and effects of these variables will be addressed in greater detail when we consider the empirical estimation results.

## **IV. Empirical Analysis**

### **IV.A. Data and Summary Statistics**

To test our theory we examine the at-issuance capital structure of Commercial Mortgage-Backed Securities (CMBS) issued during the 2004 to 2007 time period. Commercial mortgages that comprise the asset pool are collateralized by one or possibly more than one income-producing commercial property. During the sample period pool sizes vary between 50 and several hundred in terms of loans and commercial properties collateralizing the loans. The pooled mortgage loans typically contain as collateral a number of different property types, including office, warehouses, apartments and hotels. Hotel property receives particular attention in this study given its management specificity and intensity. Mortgage loan maturities generally vary between 3 and 15 years. Liability in the case of borrower default and foreclosure is limited to the pledged real estate collateral.

The pooled mortgage loans are held within a special purpose vehicle (SPV), or trust, that is bankruptcy remote. Cash flows are distributed to various claimholders based on rules established in the pooling and servicing agreement. Our focus will be on the AAA-rated senior securities, which over our sample period constituted between 83 to 90 percent of the total face value of the underlying asset pool. The lower-rated junior securities range from AA-rated to unrated.

The proportional face value of the AAA-rated securities is often expressed as a function of the “subordination level,” which is simply one minus the proportional face value of the AAA-rated securities. Senior security face values of 83 to 90 percent thus imply subordination levels of 10 to 17 percent over our sample period. Prior to the beginning of 2005, all AAA-rated CMBS issued out of an asset pool were assigned subordination levels right at the AAA-AA rating margin (i.e., the subordination level was the lowest, or close to the lowest, that could be achieved while still generating a AAA-rating for the senior securities). However, from 2005 onwards, in addition to “at-the-margin” AAA-rated securities, most issuances contained “super-senior” AAA-rated securities that had subordination levels in the 30 percent range. At 30 percent subordination the securities were considered “safe” in the sense that they were immunized against the risk of principal loss under just about any conceivable economic scenario.<sup>10</sup>

The existence of distinct super-senior (completely safe) and at-the-margin (less than completely safe) AAA-rated securities, along with informationally sensitive junior securities, conforms with model predictions when an issuer is required to satisfy demands of a safe investor clientele in order to maximize senior security issuance proceeds of securities. That is, our model uniquely predicts the existence of types or clienteles of senior bondholders that differ based on their tolerance for credit risk.

The dataset contains 1422 AAA-rated securities from 171 different issuances over the 2004 to 2007 time period. The data account for all CMBS issuances during this period, and are obtained from the CMA (Commercial Mortgage Alert) database. This database provides detailed information on senior security issuance prices and face values, asset pool credit risk characteristics, time of issuance, and the identities of the master and special servicer. As noted, during the 2004-07 sample period there were typically several AAA-rated securities issued from any particular asset pool. These securities typically differed in their expected maturity (priority on the return of paid-in principal) and, starting in 2005, in their subordination level. Because we are interested in knowing total senior (AAA-rated) security issuance proceeds and because super-senior securities are so safe as to be largely insensitive

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<sup>10</sup> To generate losses of 30 percent, default frequencies would have to exceed 50 percent with loss severities also exceeding 50 percent. This kind of forecasted loss scenario would be considered highly remote for any sufficiently populated asset pool.

to market conditions and asset pool characteristics, we focus our analysis on the at-the-margin AAA-rated securities. This reduces our sample size to 334 AAA-rated securities coming from 167 different issuances.<sup>11</sup>

The senior AAA-rated securities of interest were often sold at slight premiums to par. Figure 1 shows a scatterplot of at-the-margin AAA-rated security prices in our sample as a percentage of par (on the vertical axis), depending on the date of issuance. The 2004 to 2006 time frame was a period in which commercial property prices were generally increasing and there was broad-based optimism about the performance of the underlying collateral. In other words, anticipated liquidation discounts as expressed in our model by  $\gamma$  were, generally speaking, moderate to low, implying that IC payoffs as proxied by the senior security issuance price relative to par are predicted to be relatively high. This is precisely what the data in this figure show.

Divergence of opinion and pessimism in market outlook increased substantially in 2007, however. This occurred as property prices passed their peaks, certain investment bank and subprime lender failures began to occur, and substantial volatility and price declines were experienced in the private-label MBS and related markets, which then spilled over into CMBS market. Thus, in 2007 expectations began to be revised with respect to the strength of the asset resale market, with across-the-board markups applied to liquidity discounts,  $\gamma$ , and then to reorganization risks as measured by  $x$  in our model. This is consistent with relative senior security price declines observed in 2007. The increase in anticipated asset sales discounts from immediate liquidation made reorganization a more attractive option, which in turn reduced the IC payoff amount necessary to ensure that only efficient reorganizations occurred given that junior securityholders possessed liquidation-reorganization decision rights.<sup>12</sup>

**Figure 1 Here**

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<sup>11</sup> Certain other AAA issuances were eliminated due to incomplete or incorrect information.

<sup>12</sup> Also note that an upper bound on premiums to par seems to be about 100.50. This likely occurred because of limits on how much additional coupon interest could be allocated to senior bonds as constrained by total security coupon interest not exceeding total interest payments generated by the underlying pool of mortgages. Also note that senior bonds sometimes are issued at discounts to par, particularly during the latter 2007 time period. This kind of pricing policy is plausible in the context of our model, particularly as increasing concerns over future market conditions made it clear that liquidation in the near term would be quite costly relative to delaying liquidation through reorganization (with the potential for better market conditions in the future).

Table 1 displays summary statistics for the dependent variable of interest, AAA-rated security price relative to par, for liquidation discount measures and pool diversification measures, and for other control variables used in the regressions.

**Table 1 Here**

Senior security prices averaged 100.2 during the sample period. The average size of the asset pool is about \$318 million, with an average of 204 properties serving as collateral in each deal. The average property size is about \$2 million. Properties are identified by their type. Recall that hotel property focuses is management intensive and specific. In our sample, on average, about 6% of the properties in the pool are hotels. The securities have an expected security life of about 8 years on average, where at-the-margin AAA-rated securities were often issued with different repayment priorities and therefore different expected durations. This was especially the case for senior bonds issued earlier in the sample period. There is no clear predicted empirical relation between expected security life and relative IC payoff amount.

The weighted average loan-to-value ratio (LTV) for the pools is 68%, while the weighted average mean DSC ratio is 1.6. Both are included as control variables. LTV is a measure of solvency risks of the stand-alone real estate project, where higher LTV loans contain a greater risk of solvency-based default. DSC is a measure of borrower liquidity-based default risk as opposed to solvency-based default risk. However, with liquidity-based default and all else equal, a case for reorganization can be made to the extent that it relaxes financial constraints to the incumbent property owner-manager. If this effect is relevant, the predicted empirical relation between DSC and relative IC payoff amount is positive, since a lower DSC implies greater liquidity-based default risk and hence a lower senior security price relative to par. These two variables tend to correlate in the data, where more highly leveraged loan pools generally result in lower DSC ratios.

Table 2 shows the number of cases in which the master servicer is also the special servicer and the average senior price. In 2004, about 5% senior securities in our sample are such special servicer and master servicer are identical. The number is 9% in 2005, 5% in 2006 and 2% in 2007. Recall that alignment between master servicer and special servicer is predicted to increase the efficiency of security governance, implying the IC transfer is reduced. This is consistent with what we see in the data, although the differences are not large. The average price

of the senior security if the master special servicer is the same as the special servicer is 99.99 and the average price is 100.18 if the two entities do not align.

### **Table 2 Here**

In the data, we can also observe the b-piece (junior) security buyers. There are some cases that the junior securityholder is the same entity as the special servicer. However, the effect of aligning junior securityholder and special servicer on the IC transfer payment is unclear, as the junior securityholder controls the special servicer in either case.

Finally, we include the subordination level in our specifications to assess the robustness of our results. Subordination has no clear empirical implications due to a complex mix of factors. First, subordination level is a function of a number of credit risk factors, some of which are outside our theory and empirical model specification. Second, subordination is arguably determined simultaneous with security pricing. Simultaneity also complicates the analysis. Third, in the context of the model, there is a predicted negative relation between subordination level and senior security price, where greater relative IC payoff amounts are predicted to increase senior security face value as a measure is issuance proceeds (implying a negative relation between subordination level and senior security price relative to par). Fourth, there is an offsetting mechanical positive relation between subordination and senior security price relative to par, since senior security face value appears in the denominator of the price-to-par calculation and in the numerator of the percentage of the total deal face value that is allocated to the senior bonds. With all of these complicating effects, we do not take a stand on the anticipated direction of the effect, but do wish to include it in the empirical model specification to assess the robustness of the results of the primary variables of interest. In the data the average subordination level is 13%, with the maximum subordination level of 16.8% and the minimum of 9.4%.

## **IV.B. Empirical Specification and Regression Results**

The empirical model specification is as follows. The most important testable implication is how liquidation discount proxies, pool diversification effects and security governance measures affect senior security price to par. Thus, we write down the following baseline model specification:

$$P_i = M_i\beta_M + X_i\beta_x + N_i\beta_N + C_i\beta_C + \varepsilon_i$$

Where  $P_i$  is the relative AAA-rated security price at issuance<sup>13</sup>.  $X_i$  is a vector of variables indicate liquidation discount.  $N_i$  indicates pool diversification.  $M_i$  is a vector of security governance variables.  $C_i$  is a vector of other control variables.  $\varepsilon_i$  is an error term and  $\beta_x, \beta_N, \beta_m$  and  $\beta_C$  are coefficients to be empirically estimated. Because of the heteroskedasticity, we use robust standard errors to calculate the t-statistics in all regressions.

We consider several alternative specifications to assess the robustness of the results. First, we estimate the baseline regression model with only proxies for liquidation discount, pool diversification, security governance, and control variables. Next, we include subordination level in the regression. Since subordination level is also a function of other risk factors, it will pick up any omitted risk effects that are not controlled by variables in the baseline model. The third regression includes year fixed effects, since we observe a significant change in market conditions in 2007. The last regression includes both year fixed effects and subordination level. Table 3 shows the estimation results.

### Table 3 Here

A higher percentage of hotel property implies greater liquidation discounts than other property types, and thus results in a smaller IC transfer. Estimation results are consistent with our model prediction.

The effect of pool size with respect to the number of assets collateralizing the underlying asset pool is negative and significant. Increasingly large numbers of properties are predicted to reduce the variance of reorganization gain and loss realizations around the mean recovery value, inducing a lower IC transfer.

The coefficient on average property size is negative and significant in all four specifications. Higher average property size indicates greater management intensity and specificity, implying greater liquidation discounts. Estimates show a negative coefficient on this variable, as predicted.

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<sup>13</sup> We note that expressing the LHS variable in a regression as the senior security issuance price relative to par requires that we modify the IC payoff,  $i$ , to be expressed relative to the senior security face value. When the senior security face value depends on  $\gamma$ , as it does in our model, the comparative statics of the IC payoff amount relative to senior security face value must be recalculated. For reasons of space conservation we do not report the results, other than saying that the negative comparative static with respect to  $\gamma$  continues to hold for  $\bar{\gamma}$ . A similar relation for  $i^*$  holds for most plausible combinations of parameter values, as long as  $x$  is not too large relative to  $A^B$  and the sensitivity of  $x$  to changes in  $\gamma$  is not too high (as previously noted).

The indicator (MS=SS) has the right sign in the sense that aligning master servicer and special servicer decreases the IC transfer. However, in all four specifications, the coefficient is not significant. We will focus on this variable when we include more control variables in the augmented specifications.

Strictly speaking, our model predicts a negative relation between subordination level and IC transfer since the liquidation cost  $\gamma$  causes higher subordination level but lower IC transfer. This is what we find in the data, as baseline results confirm the negative relationship between subordination level and IC transfer.

Now consider year fixed effects. Compared to 2004, for reasons discussed earlier, the IC transfer amount in 2007 is predicted to decline relative to other years. This is what the estimation results show.

Since Figure 1 and the baseline regression results suggest that market conditions changed substantially in 2007, market conditions alone may be driving the baseline results. We include interaction terms between key variables and 2007 in the augmented regressions to assess the time effects. The results are shown in Table 4.

#### **Table 4 Here**

As we controlled for the interaction effect between security governance and year 2007, the indicator of aligning master servicer and special servicer becomes negative and significant. This result is consistent with our model prediction that the master servicer acts as a governor on the special servicer to keep it from over-extending, leading to lower IC transfer from junior securityholder to senior securityholder. The result is robust when we add subordination level in the regression.

Now consider the liquidation cost effect. The average property size has the expected sign for all years and is significant for the 2004-2006 sub-group. As discussed before, larger properties are thought to be more complex and thus demand greater management expertise, making liquidation relatively more expensive due to a thinner pool of qualified managers. Thus, larger property size implies a small IC transfer, as shown in the regression results.

Percentage of hotel is negative and significant when interacted with 2007, but insignificant for other years. One possible explanation is the divergence of opinion and pessimism in 2007. Compared with other years, 2007 results in a higher expectation of liquidation cost in near-term. Combined with the negative effect of percentage of hotel on IC transfer, the impact of this interaction term on IC payoff is consistent with our model prediction.

The estimation results reveal a negative pool diversification effect on IC transfer, consistent with the model prediction. A large number of properties imply a lower risk of experiencing high downside losses from reorganization, which reduces the need for IC payments to ensure full recovery of the senior security face value for investors.

The DSC and LTV estimation results are interesting in the final set of regressions. In 2007, higher LTVs result in greater IC payoffs, while higher DSCs generate the same relationship. A lower DSC implies a more liquidity constrained borrower, implying that *ceterus paribus* a shortage of cash in a time of weakening market conditions favors reorganization. This may result because forbearance helps the cash-constrained borrower to regroup and move forward. In contrast, greater LTVs imply an increase in the IC payoff amount. Underinvestment may be the concern, where borrowers that are more underwater have fewer incentives to manage their properties. As a result it may be preferable to liquidate, requiring a higher IC payoff amount.

#### IV.D. Robustness Check

In this section, we examine the robustness of our model specification given the apparent truncation in the senior security price relative to par. We change the empirical model specification to allow right-censored price at 100.5.

$$P^*_i = M_i\beta_M + X_i\beta_x + N_i\beta_N + C_i\beta_C + \varepsilon_i$$

$$P_i = 100.5; \text{ if } P^*_i \geq 100.5$$

$$P_i = P^*_i; \text{ if } P^*_i < 100.5$$

In this specification,  $P^*_i$  is an unobserved or latent variable, and is determined by the same set of explanatory variables that we discussed before. If the unobserved price is greater than 100.5, we cannot observe the true price since the security is priced at 100.5. If the unobserved price is below 100.5, it is actually the observed price. Table 5 shows the regression results. Note that because of the heteroskedasticity, we still use robust standard errors to calculate the t-statistics in all regressions.

**Table 5 Here**

Overall, the censoring regression results are consistent with our previous regression results. We find a negative relationship between the indicator (MS=SS) and the IC payoff. The negative correlation between the pool diversification effect and the IC payoff is also robust, as indicated by the number of properties. We also find a negative liquidation discount effect on the IC transfer. For example, the property size has a negative impact on IC payoff. The coefficient before the percentage of hotel interacted with 2007 is also negative and significant.

To sum up, our estimation results are generally consistent with our model predictions, in that we find strong liquidation discount and pool diversification effects. We also find a security governance effect.

## **V. Conclusion**

In this paper we introduce a novel theory that explains: i) security tranching not only based on fundamental credit risks but also based on information frictions, ii) the optimal governance of these tranced securities, and iii) how to achieve incentive compatible capital structure design through security tranching and proper governance structure. The data support predictions of the theory, which lends credibility to the assertion that at least certain securitization product markets were intelligently structured and fairly managed. The theory is also highly normative in its content, laying out a roadmap for private market participants as well as policymakers on how to increase the “goods” associated with securitization while at the same time reducing the “bads”, and doing so based on incentives rather than red tape.

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Figure 1: Scatter Plot For AAA-rated Security Price



Table 1 Summary Statistics

	Price -to- Par	Sec Life	Sr Sec Amount	Number of Assets	Av Prop Size	LTV	D S C	% Hotel	Sub Level
Mean	100. 2	8.1	318	204	2.0	68.0	1.6	5.9	13.0
Median	100. 5	9.8	187	178	0.9	68.4	1.6	4.8	12.9
Min	95.5	0.6	34	73	0.2	55.9	1.2	0.0	9.4
Max	100. 6	10.0	2627	924	14.3	75.6	2.8	29.9	16.8
N	334	334	334	334	334	334	334	334	334

This table shows the summary statistics of data in the sample period. Price-to Par is the issuance price of senior security relative to par. Sec Life is the duration of the security in years. Sr Sec Amount is the face value of senior security in millions. Number of Assets is the total number of properties in the asset pool. Av Prop Size is the average property size in the asset pool. LTV is the weighted average loan-to-value ratio. DSC is the weighted average debt service coverage ratio. %\_Hotel is the percentage of hotel in the asset pool. Sub Level is the subordination level of AAA-rated securities.

Table 2 Average Price and Number Of Senior Securities By Issuance Year And Indicator (MS=SS)

	2004		2005		2006		2007		Total	
	Price Mean	Freq								
MS not =SS	100.36	164	100.28	51	100.26	52	99.39	50	100.18	317
MS=SS	99.89	8	100.41	5	99.56	3	100	1	99.99	17
Total	100.34	172	100.2959	56	100.22	55	99.4	51	99.4	334

This table shows average price and number of securities by issuance year and by indicator if master servicer is also the special servicer.

Table 3 Baseline OLS Regression Results

	Model 1		Model 2		Model 3		Model 4	
	Coef.	t-st	Coef.	t-st	Coef.	t-st	Coef.	t-st
MS=SS	-0.13	-0.69	-0.12	-0.65	-0.24	-1.3	-0.23	-1.25
B-piece=SS	0.004	0.04	-0.0002	-0.001	0.00	-0.03	-0.01	-0.100
Sr Security Life	0.001	0.08	-0.001	-0.09	0.01	0.32	0.01	0.41
Sr Security Size	0.0003	1.45	0.0004	1.49	0.0004	1.59	0.0004	1.77
Number of Assets	-0.001**	-2.02	-0.001**	-2.09	-0.001	-1.58	-0.001	-1.62
Av Property Size	-0.10**	-2.96	-0.10**	-2.96	-0.10**	-3.03	-0.11**	-3.10
LTV	0.01	0.67	0.02	0.82	0.003	0.17	0.01	0.67
DSC	0.39	1.38	0.41	1.42	0.05	0.23	0.01	0.04
%_Hotel	-0.04**	-2.98	-0.04**	-2.91	-0.03	-2.15	-0.03**	-2.12
Sub Level			-0.03	-0.86			-0.07**	-2.04
Y-2005					0.02	0.23	-0.06	-0.61
Y-2006					0.05	0.42	-0.09	-0.68
Y-2007					-0.76**	-3.81	-0.91**	-4.20
Constant	99.22	55.78	99.20	55.61	100.38	62.28	100.69	66.35
Numbers	334		334		334		334	
R-Sq.	0.146		0.148		0.256		0.266	

This table shows the regression results for price in sample period 2004-2007 with different model specifications.

Table 4 Augmented OLS Regression Results

	Model 1		Model 2	
	Coef.	t-st	Coef.	t-st
MS=SS	-0.39**	-2.3	-0.39**	-2.3
B-piece=SS	-0.11**	-2.01	-0.11**	-2.01
Sr Security Life	0.002	0.16	0.002	0.15
Sr Security Size	0.00003	0.18	0.00003	0.16
Number of Assets	-0.001**	-2.00	-0.001**	-2.00
Av Property Size	-0.06**	-2.07	-0.06**	-2.06
LTV	-0.02**	-2.29	-0.03**	-2.23
DSC	-0.31**	-2.31	-0.31**	-2.3
%_Hotel	0.00	0.41	0.00	0.43
Y-2005	-0.07	-0.83	-0.07	-0.77
Y-2006	-0.17	-1.64	-0.16	-1.51
Y-2007	-10.22	-1.19	-9.48	-0.92
Y2007*MS=SS	1.17**	2.77	1.16**	2.8
Y2007*B-piece=SS	0.30	0.77	0.30	0.79
Y2007*Security Life	-0.11	-0.96	-0.11	-0.94
Y2007*Security Size	0.00	1.51	0.00	1.5
Y2007*Number of Assets	0.00	-0.62	0.00	-0.63
Y2007*Av Property Size	-0.65	-0.58	-0.69	-0.59
Y2007*LTV	0.10	1.37	0.10	1.37
Y2007*DSC	3.05	1.3	2.84	1.02
Y2007*% Hotel	-0.08**	-2.24	-0.08**	-2.25
Sub Level			0.00	0.24
Y2007*Subordination Level			-0.03	-0.12
Constant	102.8935	110.77	102.90	110.07
Numbers		334		334
R-Sq.		0.363		0.363

This table shows the augmented regression results for price in sample period 2004-2007. Interaction terms between 2007 and key variables are included in the regressions.

Table 5 Right Censored Tobit Model Regression Results

	Model 1		Model 2	
	Coef.	t-st	Coef.	t-st
MS=SS	-0.57**	-2.52	-0.58**	-2.54
B-piece=SS	-0.16	-1.41	-0.16	-1.42
Sr Security Life	-0.003	-0.09	-0.003	-0.1
Sr Security Size	-0.0002	-0.45	-0.0002	-0.5
Number of Assets	-0.001**	-2.23	-0.001**	-2.25
Av Property Size	-0.09*	-1.87	-0.09*	-1.82
LTV	-0.04	-1.46	-0.04	-1.49
DSC	-0.13	-0.32	-0.13	-0.33
%_Hotel	0.01	0.68	0.01	0.72
Y-2005	-0.18	-0.98	-0.16	-0.82
Y-2006	-0.35	-1.58	-0.32	-1.34
Y-2007	-15.62**	-2.25	-13.09**	-1.52
Y2007*MS=SS	1.21	1.39	1.21	1.39
Y2007*B-piece=SS	0.36	1.27	0.34	1.21
Y2007*Security Life	-0.01	-0.02	0.00	-0.01
Y2007*Security Size	-0.01	-0.02	-0.002	-0.01
Y2007*Number of Assets	0.005*	1.72	0.005*	1.79
Y2007*Av Property Size	-0.002	-0.84	-0.002	-0.97
Y2007*LTV	0.14**	2.25	0.14**	2.21
Y2007*DSC	4.16**	2.46	3.43**	1.54
Y2007*% Hotel	-0.10**	-3.38	-0.10**	-2.77
Subordination Level			0.02	0.36
Y2007*Subordination Level			-0.12	-0.57
Constant	104.2297	42.23	104.25	42.24
Uncensored Numbers		208		208
Pseudo R-Sq.		0.168		0.169

This table shows the Tobit regression results for price in sample period 2004-2007. Interaction terms between 2007 and key variables are included in the regressions.