Designed for Failure? Risk-Return Tradeoffs and Risk Management of Structured Investment Vehicles

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Big Picture

- Structured finance has emerged as an increasingly important means of transferring risk and obtaining access to capital.
- However, recent notable failures raise several questions as to the design and assessment of these structured deals.
  - SIVs alone held an estimated $400 billion in assets, and of the 29 SIVs in existence prior to the crisis, none remain today. Ultimately, senior note holders of AAA-rated debt experienced an average 50% loss.
  - Expanding our scope to the realm of all balance-sheet and off-balance-sheet deals brings the total to the trillions of dollars.
- Our purpose is to explore whether these deals were structured in a way that was likely to provide safe returns to senior note holders.
- Of particular interest, are the implications of the risk-management controls of the SIV itself, which remains relatively unexplored.

What Is Structured Finance?

- A structured finance deal entails the pooling and tranching of assets into prioritized cash-flow claims
  - The asset pool may comprise a wide range of fixed income and credit assets, such as bonds, mortgages, RMBS, CMBS, as well as other ABS collateralized by credit card loans, auto loans, home-equity loans, etc.
- This method allows a class of AAA-rated claims, called the senior tranche, to be created from a pool of non-AAA rated assets (i.e., there is a subordinated equity tranche that bears first losses)
- To provide further protection to senior note holders, the structured investment vehicle (SIV) outlines basic covenants pertaining to collateral quality, correlation, duration, liquidity, etc.
- In addition, the SIV is monitored on an ongoing basis primarily through a leverage test, whereby the ratio of collateral value to senior-note obligations must meet a pre-specified cutoff.

Related Work

- Given their complexity and widespread importance, there is a growing body of work exploring the securitization and design of special purpose vehicles
  - DeMarzo and Duffie (1999): examine the role of information and liquidity costs inherent in selling tranches of a structured finance deal
  - DeMarzo (2005): demonstrates liquidity efficiencies to creating low-risk senior notes from the pooling and tranching of asset-backed securities
  - Coval, Jurek, and Stafford (2009a): argue that senior tranches are akin to economic catastrophe bonds, and offer lower compensation than investors should require
  - Coval, Jurek, and Stafford (2009b): demonstrate that small errors in correlation estimates of the collateral pool results in a large variation in actual riskiness of the senior tranches
  - Gennaioli, Shleifer, and Vishy (2013): argue that the shadow banking system can be welfare improving, but is vulnerable when investors ignore tail risks
- We explore a very different aspect of structured vehicle design: specifically, the effect of the *operating risk controls* themselves on the quality of tranches issued by the SIV

A Simple Example

- Consider a SIV with assets A(t)=$100.
- Suppose the senior tranche size, D_B, is $92.
- Suppose a lower bound of K=1.04 is placed on the A(t)/ D_B ratio.
  - This means that the SIV enters defeasance when assets drop to A(t) = 92*1.04 = $**95.68**
  - Thus, senior-note holders receive $92, and the equity/capital-note holders are left with 95.68 – 92 = $3.68, which translates to a 54% loss (though the assets themselves did not drop nearly as much in value)
- Now if there is a fire-sale discount, the senior-note holders may not fare so well.
  - Under a 10% discount, there is only 95.68*90% = $86.11 left to disburse to senior-note holders
  - Thus, senior-note holders sustain a 6.4% loss, and capital-note holders suffer total loss

Our Purpose

- Thus, we see that the expected loss to senior-note holders depends critically on:
  - The credit quality of the underlying asset pool
  - The size of the senior tranche
  - The expected fire-sale discount
  - The risk controls outlined by the SIV (in our case, the leverage threshold)

- Our purpose is to examine whether the risk management controls and overall structure in place were sufficient to ensure safe returns to senior note holders, and how sensitive are these assessments to various key parameters that determine expected losses?

Preview of Results

- Rather than providing safety, we find that stringent risk management controls can exacerbate expected losses to senior note holders
  - Expected losses are very sensitive to leverage controls, oftentimes more so than to the riskiness of the underlying assets
  - Expected losses to senior notes become increasingly sensitive to the riskiness of the underlying assets as leverage controls become more stringent
- Based on choice of leverage control, we find that small changes in the fire-sale discount can substantially alter the expected losses to senior notes
- Finally, we find that an 'optimal' AAA-rated SIV design can yield substantial expected losses based on small changes to key parameter inputs
  - Thus, stress tests must account not only for potentially vast swings in asset volatility, but also for swings in other factors, such as the fire-sale discount

Notation and Setting

- Value of the underlying asset pool is $A(t)$, with asset spread factor $s(t)$ and spread volatility σ
- The size of the senior tranche is D_B, and the equity tranche is D_C
- The leverage constraint, K, denotes the level of $A(t)/D_B$ at which defeasance is triggered
  - i.e., no defeasance as long as $A(t)$ remains above $K \times D_B$
- Time to maturity is denoted by T
- Fire-sale discounts are denoted by δ

How to Capture Probability of Defeasance

- The SIV enters defeasance mode when assets, A(t), depreciate to access a lower barrier: $K \times D_B$

- Thus, the expected loss on senior notes is captured by:

$$E(L) = \overbrace{\max(0, \underbrace{D_B}_{\text{amount owed}} - \underbrace{(1-\delta)D_B K}_{\text{amount received upon defeasance}})}^{\text{loss upon defeasance}} \underbrace{\int_0^T e^{-r\tau} f[A(\tau) = D_B \cdot K \mid A(t) > D_B \cdot K, \forall t < \tau] d\tau}_{\text{probability of defeasance}}$$

- To derive this first-passage probability density, we use barrier options: a class of exotic derivative securities that are activated or de-activated when the value of the underlying asset hits some pre-specified barrier
  - Specifically, we calculate the value of a cash-or-nothing binary barrier option, which pays \$1 the moment A(t) touches the designated barrier (or, equivalently, the moment the asset spread s(t) appreciates to some corresponding upper barrier)

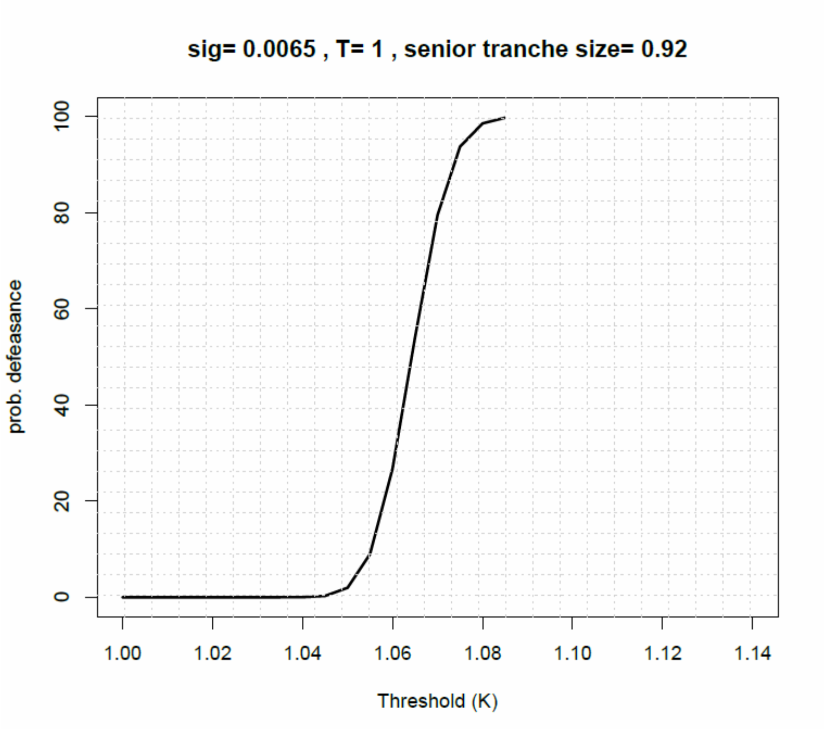
Analyses

- Thus, expected losses depend crucially on:
  - The size of the senior tranche: D_B
  - The credit quality of the underlying asset pool: s(t) and σ
  - The time to maturity: T
  - The leverage threshold outlined by the SIV: K

- We now proceed to examine how the risk controls, capitalization, rollover horizon, and pool risk interact to determine the expected losses (and hence, the credit ratings) on the senior notes of a given SIV

Figure 1: Probability of Defeasance

- Probability of defeasance plotted against the leverage threshold, K.
- Base case parameters: A(0)=s(0)=1, T = 1 yr, r=0.02, σ=0.0065.



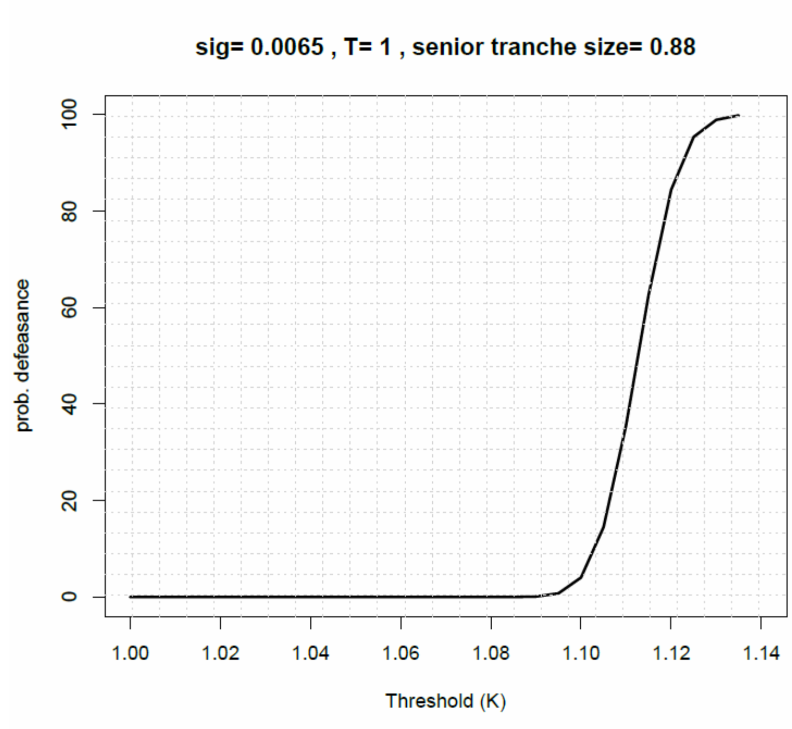
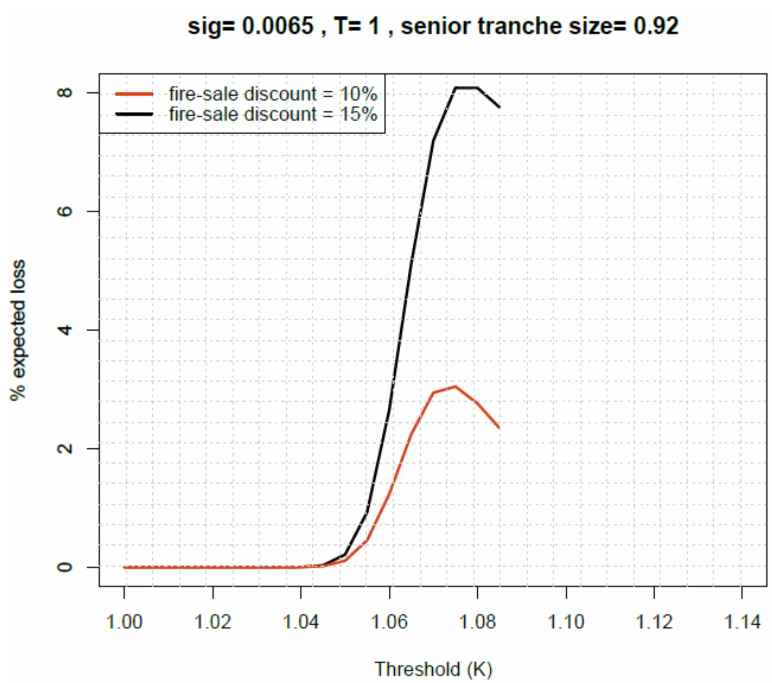


Figure 2: Percentage Expected Loss (1-yr horizon)

- Percentage expected loss plotted against the leverage threshold, K.
- Base case parameters: A(0)=s(0)=1, T = 1 yr, r=0.02, σ=0.0065, δ={10%, 15%}.



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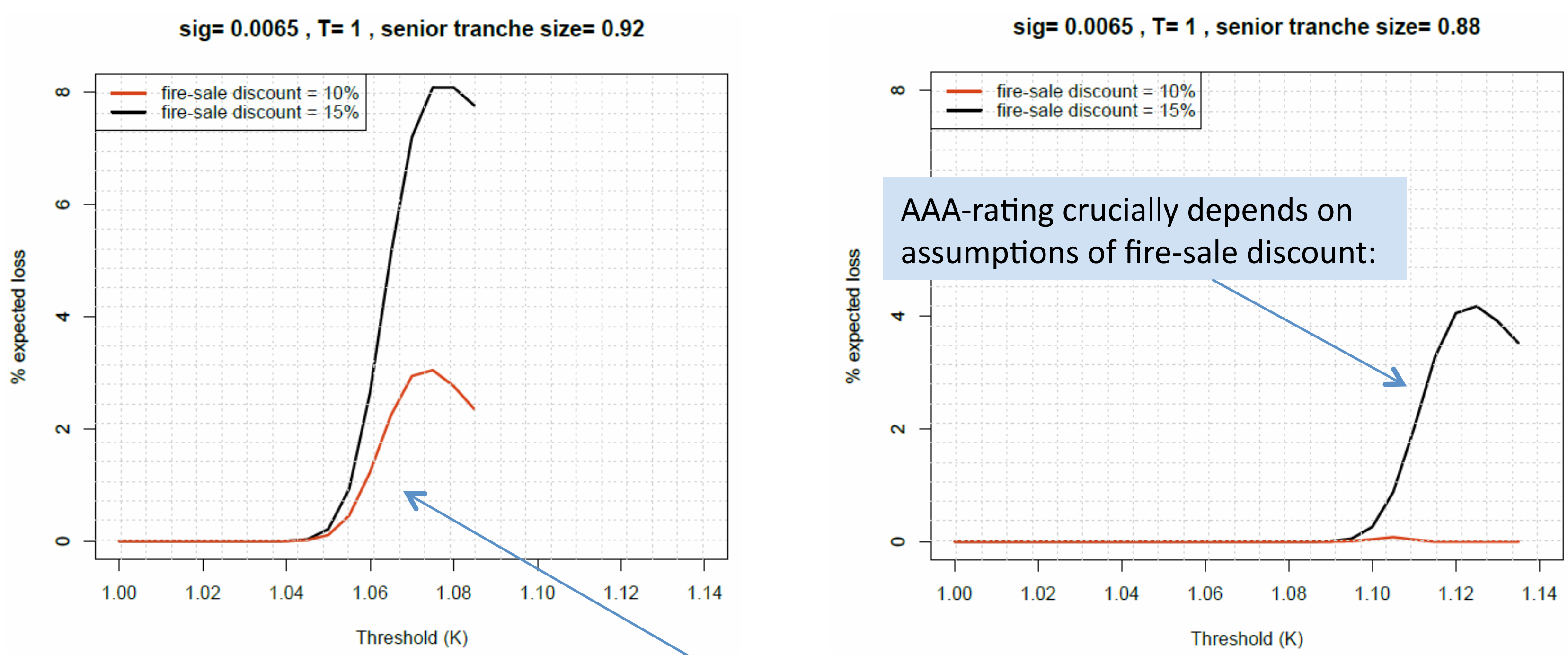
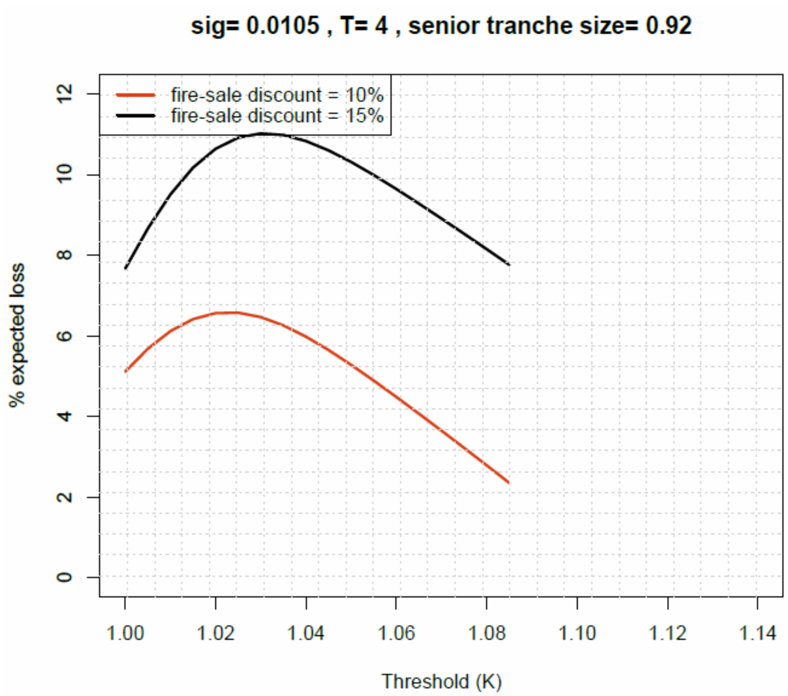
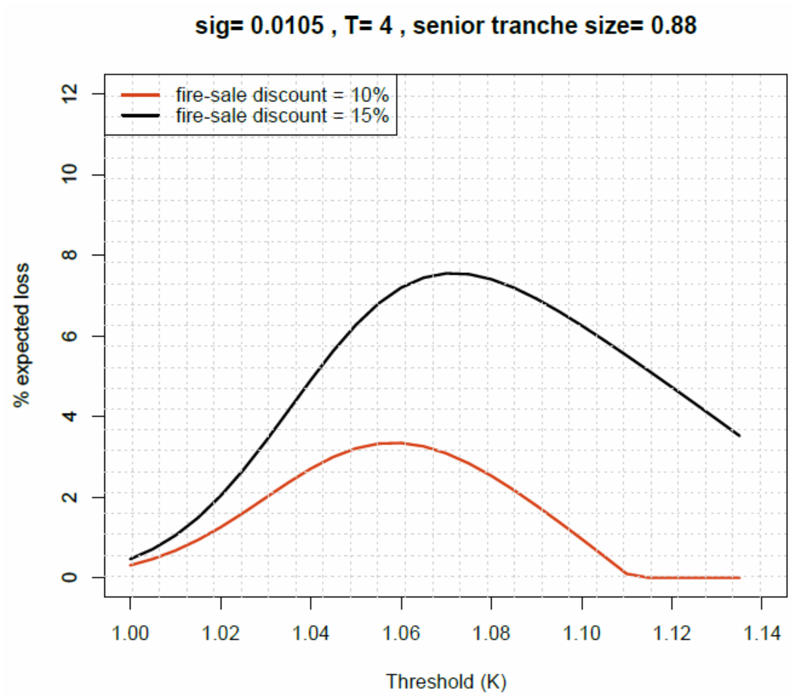


Stringent risk controls can increase rather than decrease expected losses.

Figure 3: Percentage Expected Loss (4-yr horizon)

- Percentage expected loss plotted against the leverage threshold, K.
- Base case parameters: A(0)=s(0)=1, T = 4 yrs, r=0.02, σ=0.0105, δ={10%, 15%}.

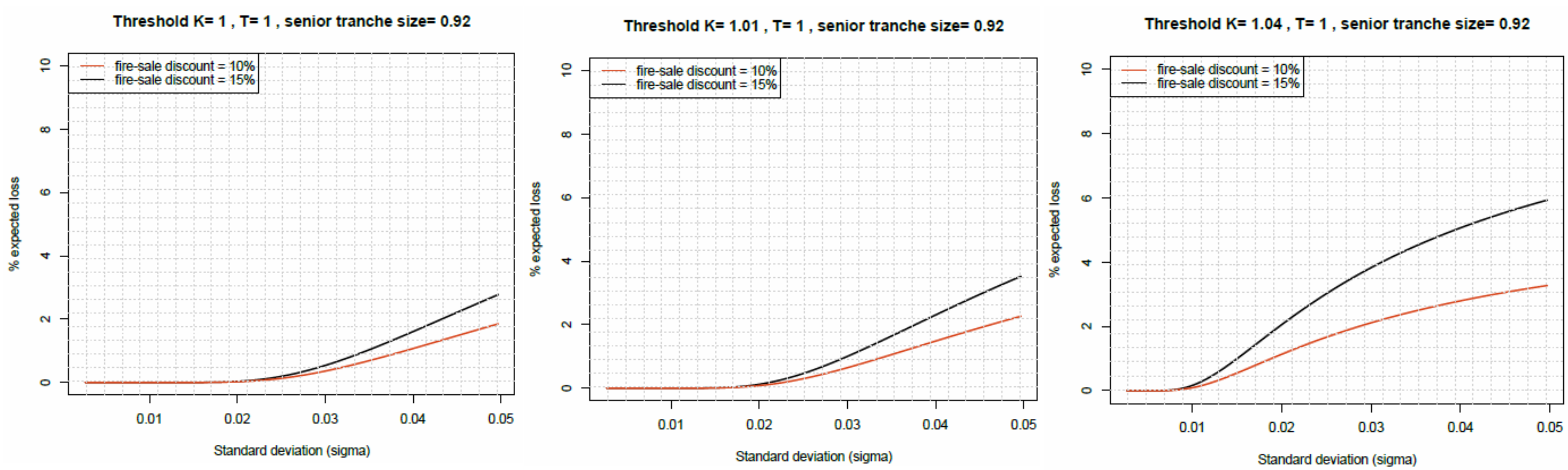




Under longer horizons, we see high expected losses that are too high to justify a AAA rating for larger senior tranche sizes

Figure 4: Percentage Expected Loss (D_B=92%)

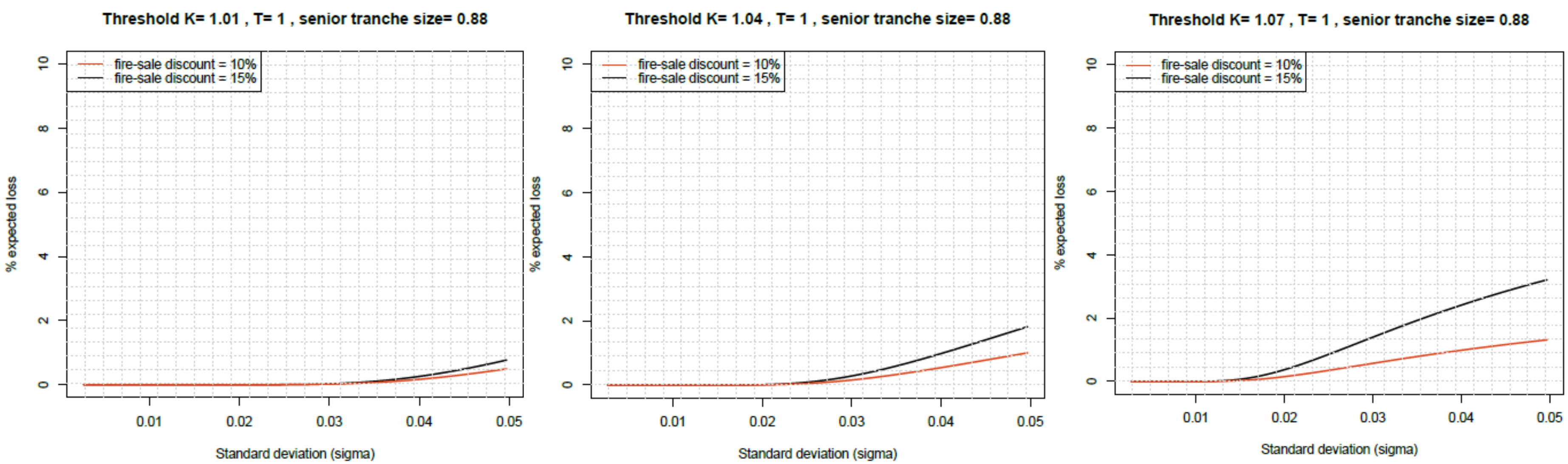
- Percentage expected loss plotted against spread volatility, σ.
- Base case parameters: D_B=0.92, A(0)=s(0)=1, T = 1 yr, r=0.02, δ={10%, 15%}.



Expected losses are increasingly sensitive to pool risk under stricter leverage thresholds!

Figure 5: Percentage Expected Loss (D_B=88%)

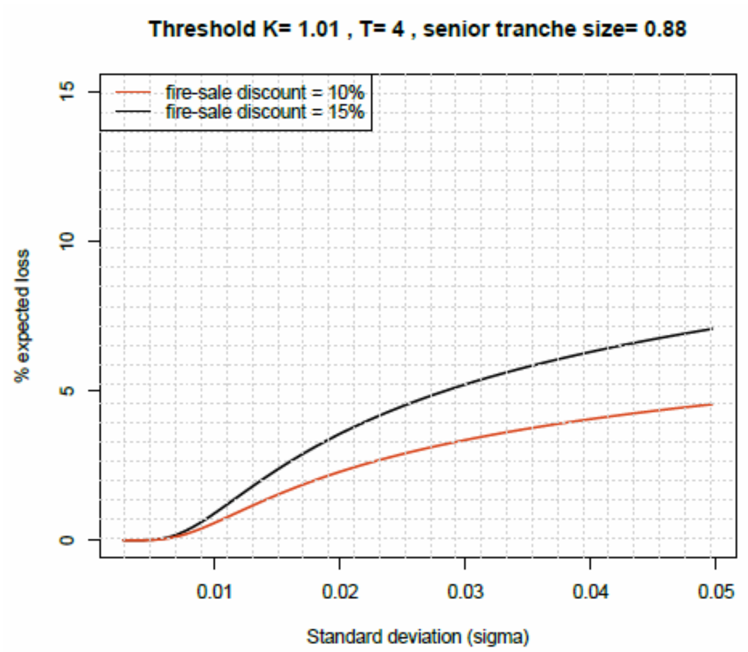
- Percentage expected loss plotted against spread volatility, σ.
- Base case parameters: D_B=0.88, A(0)=s(0)=1, T = 1 yr, r=0.02, δ={10%, 15%}.

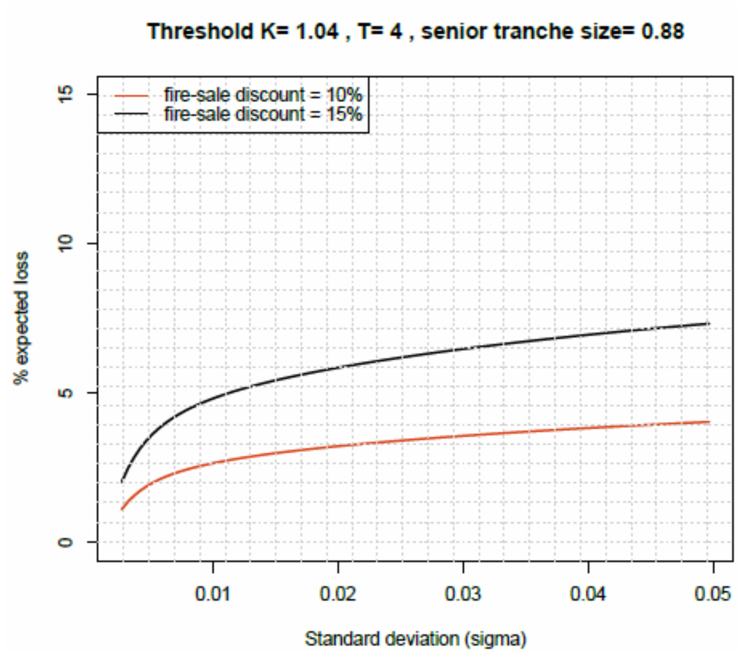


Again, we see that expected losses are increasingly sensitive to pool risk under stricter leverage thresholds!

Figure 7: Percentage Expected Loss (D_B=88%)

- Percentage expected loss plotted against spread volatility, σ.
- Base case parameters: D_B=0.88, A(0)=s(0)=1, T = 4 yrs, r=0.02, δ={10%, 15%}.





Under longer horizons, we see high expected losses that are too high to justify a AAA rating, even under smaller senior tranche sizes

Summary of Results Thus Far

1. Expected losses to senior note holders increase dramatically with the leverage constraint

2. The extent to which the leverage constraint matters, depends crucially on a combination of the senior tranche size and the assumed fire-sale discount

3. As leverage controls become more stringent, expected losses become even more sensitive to the volatility of the underlying assets

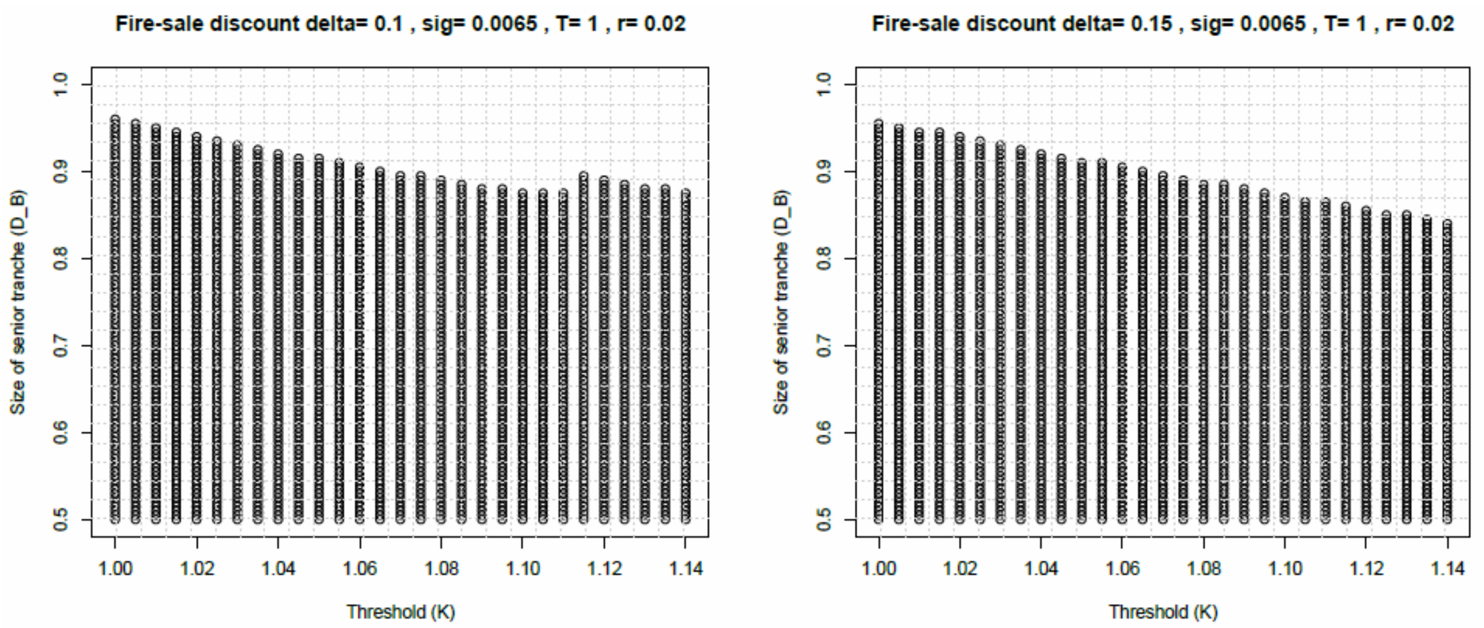
- Now let's turn to examine how vastly the optimal SIV design can change as we alter key parameter estimates…

Exploring Viability of 'Optimal' SIV Design

- Suppose a SIV's goal is to issue the largest senior tranche size possible, while maintaining a AAA rating (i.e., keeping expected losses below 0.01%)
- We begin by plotting all combinations of $\{D_B, K\}$ pairs that yield expected losses no greater than 0.01%
- Then we examine how the maximal senior tranche size, D_B, differs based on changes in the fire-sale discount
  - This consideration is particularly important given the highly uncertain nature of fire-sale discounts in times of distress
  - E.g., Cheyne Finance recovered 44% of par value in initial liquidation rounds, and Sigma Finance recovered 15%.
  - Thus, stress tests of SIV design must account not only for swings in underlying asset volatility, but also for possible swings in fire-sale discounts under defeasance

Figure 8: SIV Design (selecting D_B and K)

- Senior-tranche size (D_B) and the leverage threshold (K) pairs resulting in a percentage expected loss ≤ 0.01%
- Base case parameters: A(0)=s(0)=1, T = 1 yr, r=0.02, σ=0.0065, δ={10%, 15%}.



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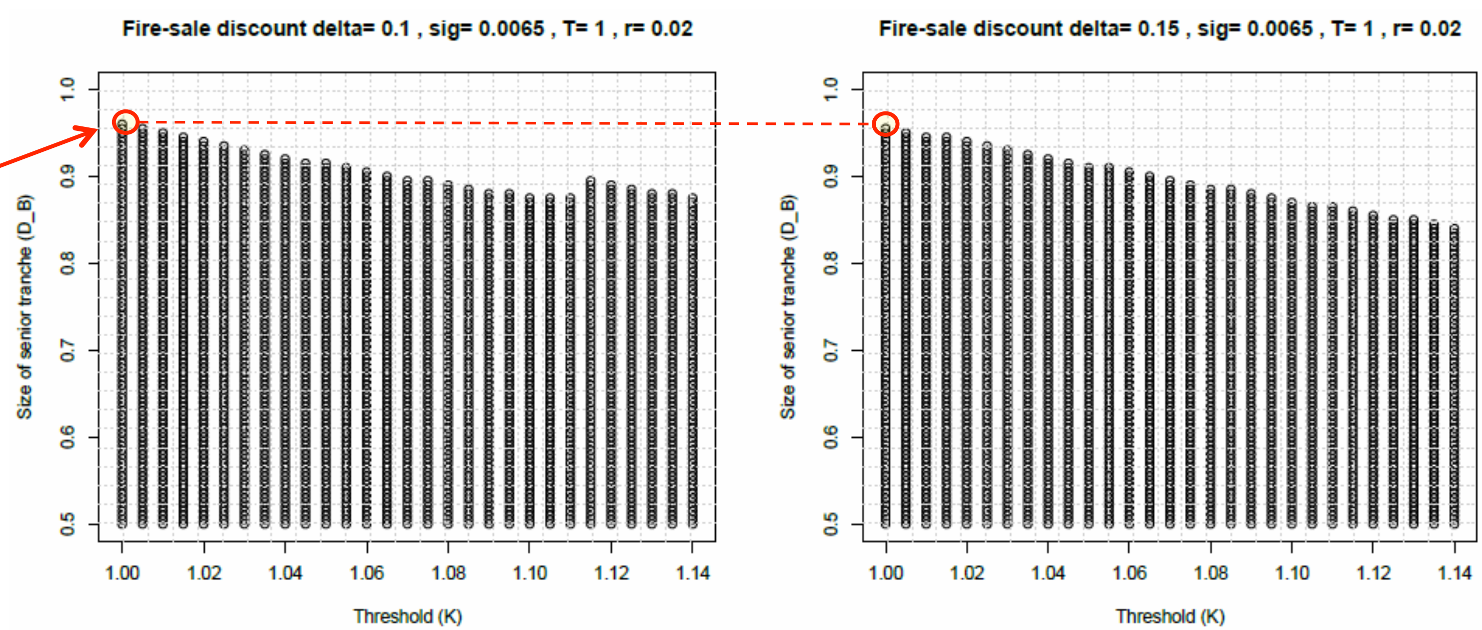
Whether we assume δ=10% or 15%, the largest feasible D_B is the same, with a leverage constraint of K=1



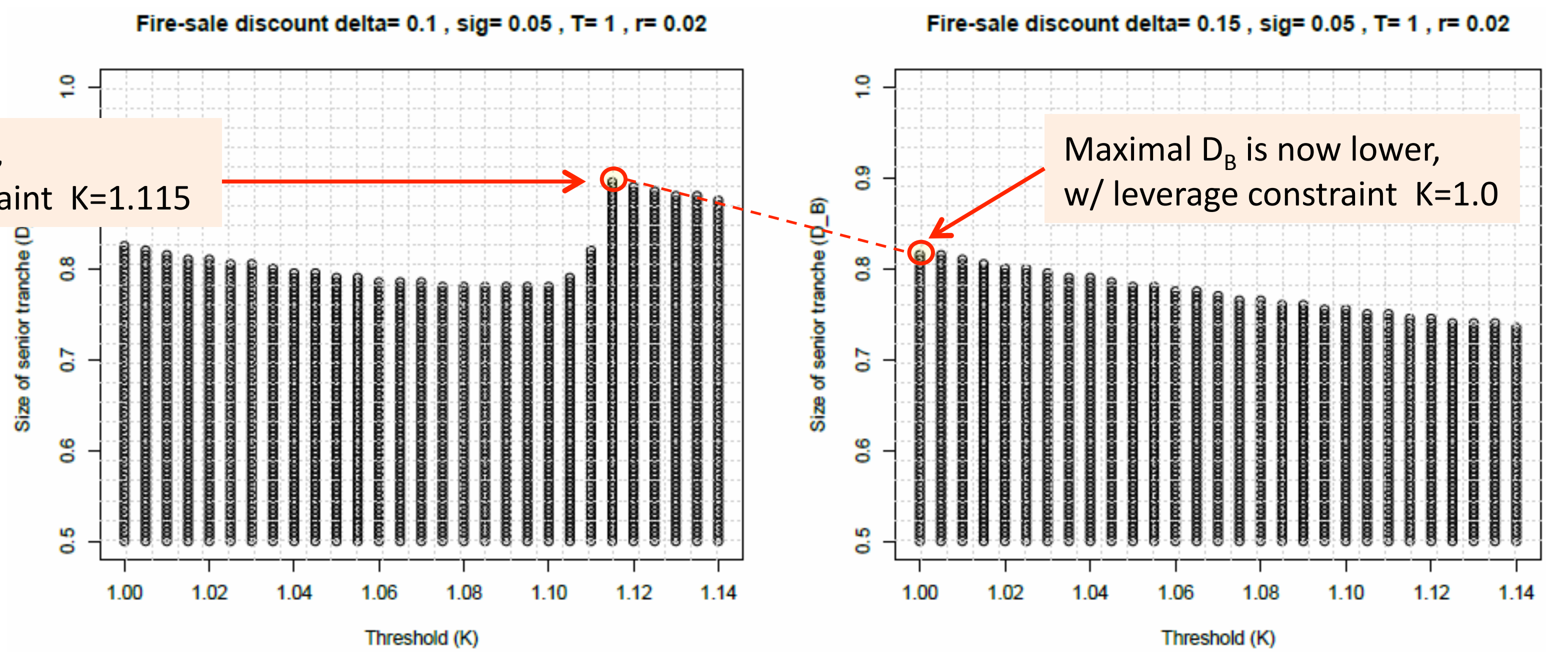
Under normal economic conditions, SIV design would be the same whether we assume higher or lower fire-sale discount

Figure 8: SIV Design (selecting D_B and K)

- Senior-tranche size (D_B) and the leverage threshold (K) pairs resulting in a percentage expected loss ≤ 0.01%
- Base case parameters: A(0)=s(0)=1, T = 1 yr, r=0.02, σ=0.05, δ={10%, 15%}.

Maximal D_B=0.893,
w/ leverage constraint K=1.115

But if δ=15%,
this design has
an expected loss
of 5.2%!

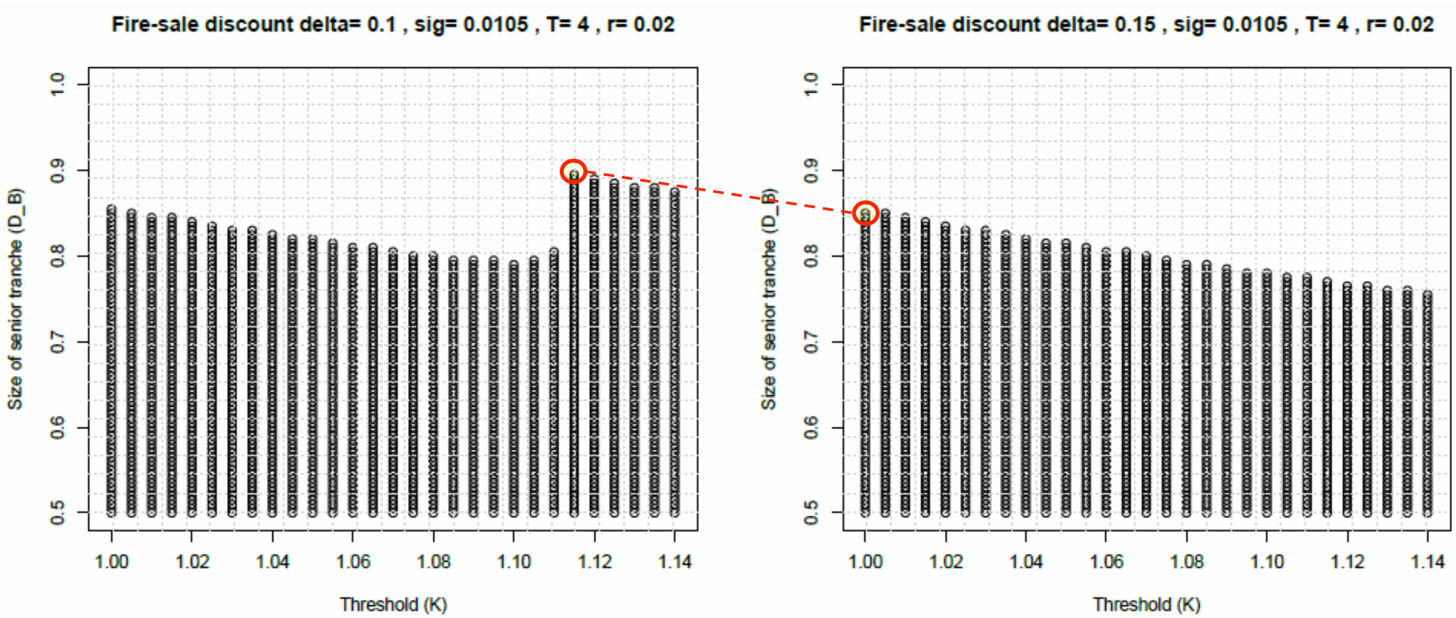


Maximal D_B is now lower,
w/ leverage constraint K=1.0

… Thus, under stressed conditions, SIV design vastly differs!

Figure 9: SIV Design (selecting D_B and K)

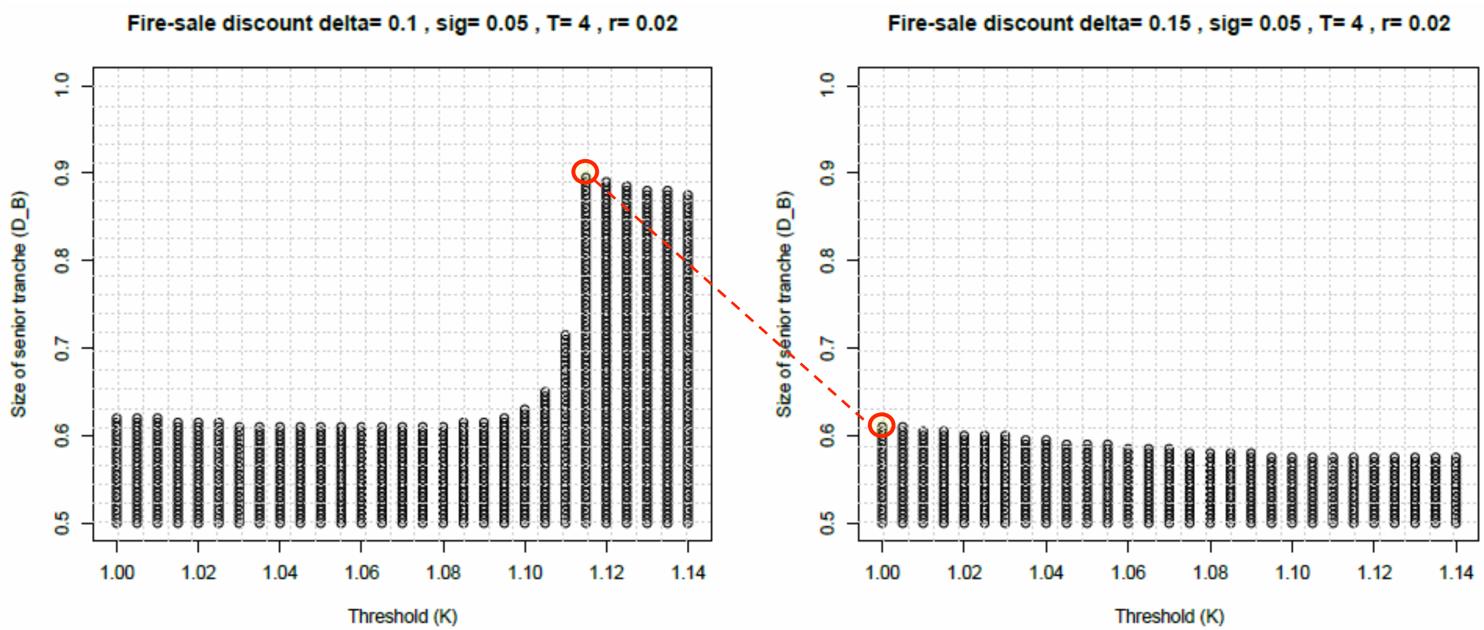
- Senior-tranche size (D_B) and the leverage threshold (K) pairs resulting in a percentage expected loss ≤ 0.01%
- Base case parameters: A(0)=s(0)=1, T = 4 yrs, r=0.02, σ=0.0105, δ={10%, 15%}.



For longer horizons, SIV design materially differs even under normal economic conditions.

Figure 9: SIV Design (selecting D_B and K)

- Senior-tranche size (D_B) and the leverage threshold (K) pairs resulting in a percentage expected loss ≤ 0.01%
- Base case parameters: A(0)=s(0)=1, T = 4 yrs, r=0.02, σ=0.05, δ={10%, 15%}.



… and this difference becomes even more dramatic under stressed conditions

Concluding Remarks

- Overall, we provide normative prescriptions as to the risk management of structured deals.
- Interestingly, instead of providing safety, stringent risk management controls can accelerate the chances of failure and dramatically increase the expected losses to senior-note holders.
- Furthermore, expected losses become increasingly sensitive to underlying pool risk as leverage controls become more stringent.
- Finally, small changes in parameter assumptions (e.g. the fire-sale discount) lead to very different ‘optimal’ SIV designs, which in reality are too fragile to ensure repayment to senior-note holders with AAA-level certainty.

Thank you.