GUY CARPENTER

Capital Tranching: A RAROC Approach to Assessing Reinsurance Cost Effectiveness

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MARSH & McLENNAN COMPANIES

Goals for Today

- Published in Variance
  www.variancejournal.org/issues/07-01/72.pdf
- Genesis: 2006 presentation to a CFO who came from banking:
  - Presenting a cat reinsurance program with average 10% ROL
  - He said, "Why should I pay 1000 basis points when I can borrow at 300?"
  - And so it began….
- Long credibility struggle because it indicates you might want to buy more reinsurance
- Not just GC:
  Kevin O'Donnell (Ren Re) and Chris Culp (U Chicago)
  "*Catastrophe reinsurance and risk capital in the wake of the credit crisis*"
  www.rmcsinc.com/articles/NatCatJRF.pdf

Reinsurance is a Capital Substitute

- Capital has a cost
- Reinsurance should reduce that cost
- Reinsurance has a cost
  - "Economic Cost" (also called "Ceded Profit") = Premium – Expected Recoveries
- Reinsurance Cost/Benefit analyses are increasingly common
- They use an Internal Capital Model to calculate loss distribution Gross and Net of Reinsurance

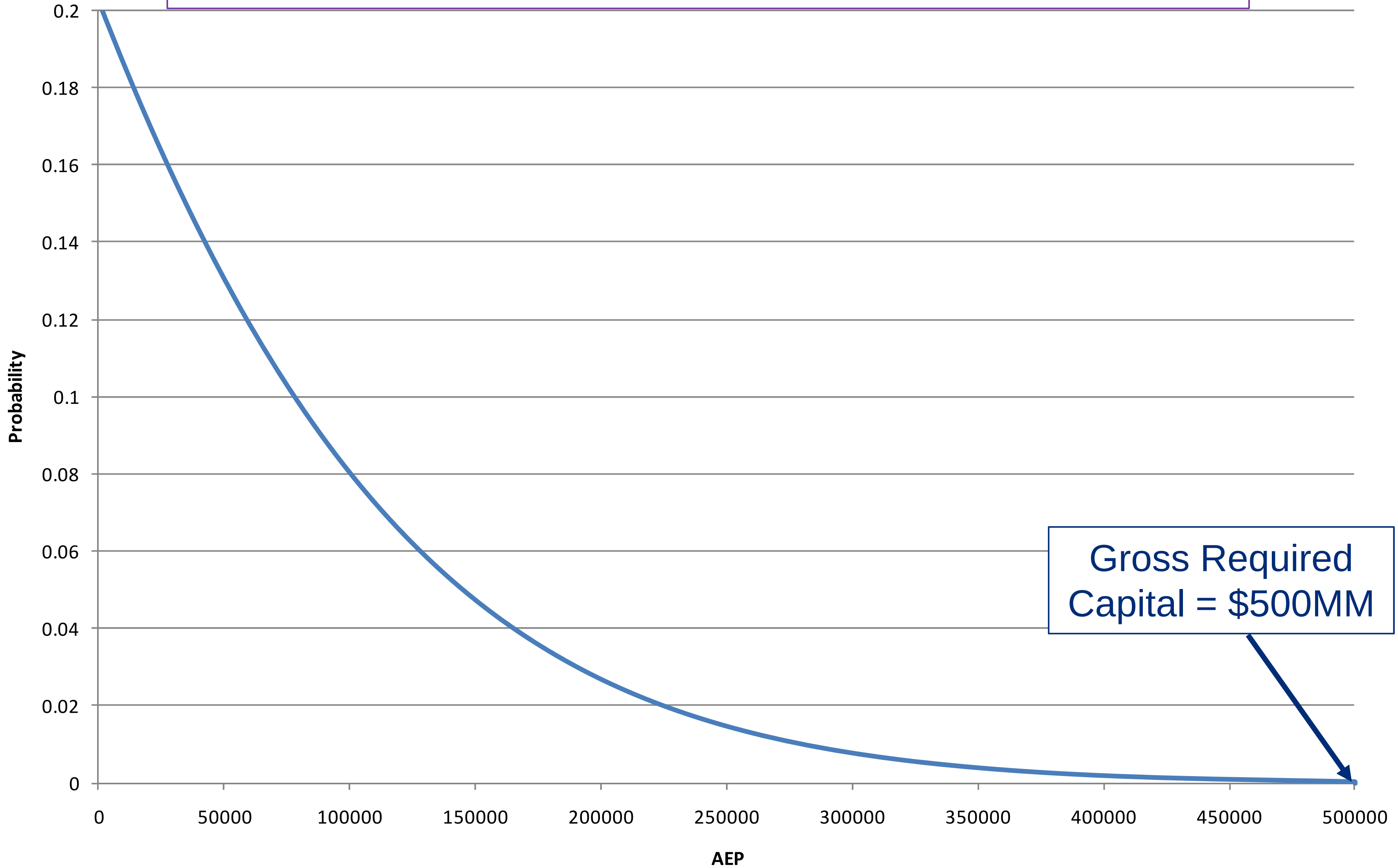
Evaluating Reinsurance Effectiveness
Current Industry Standard Approach (ISA)

- Required risk capital = loss at some remote return period
- E.g., VaR@99th percentile
- Both Gross and Net of reinsurance.
- The difference between these is the **required capital savings**.
- Multiply that by a **capital cost rate** (or "**hurdle rate**") – typically something like 15 percent.
- The product is the **capital cost reduction**.
- If Ceded Profit > Capital Cost Reduction ➔ **RED LIGHT**
- If Ceded Profit < Capital Cost Reduction ➔ **GREEN LIGHT**

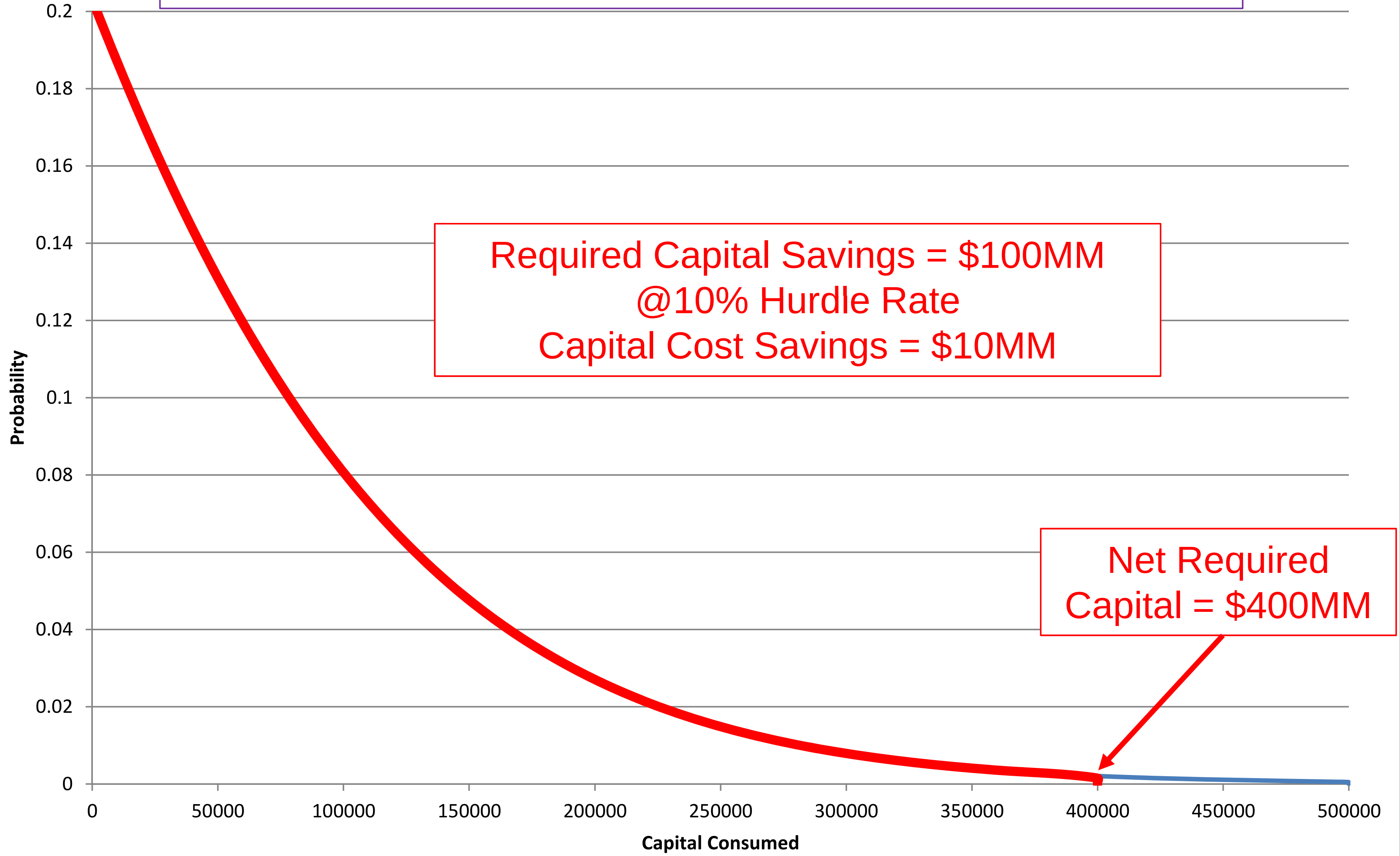
Pictorial Example Using Catastrophe Reinsurance

- Loss distribution = “Exceedance Probability” or EP Curve from a catastrophe (“cat”) model
- Stylized example
- Simplifying these so we can focus on the dynamics
  - Ignoring premium, accounting, etc.

Cat EP Curve
"Unexpected Loss" = Loss – Expected Loss

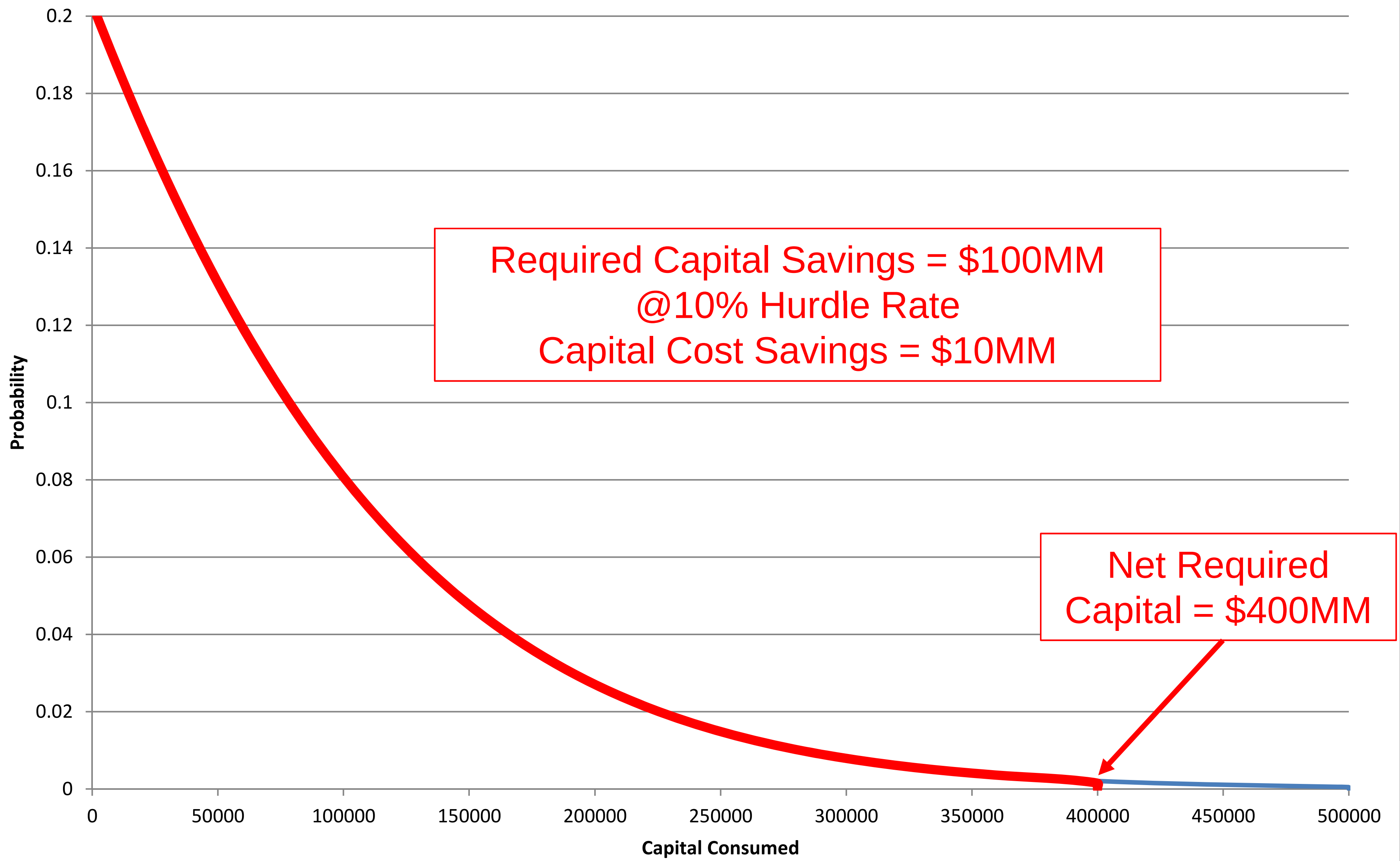


ISA Evaluation
100MM xs 400MM Reinsurance

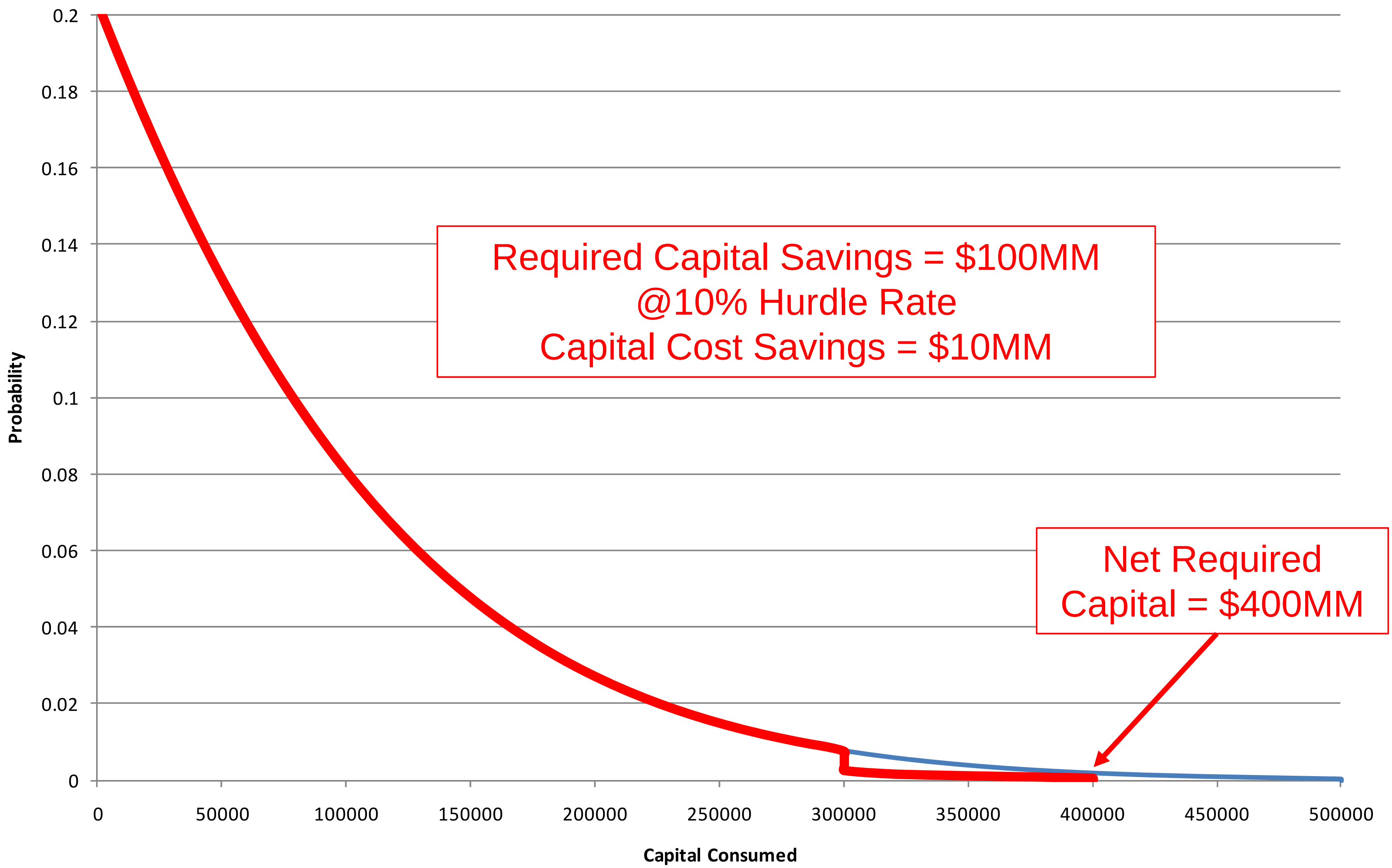


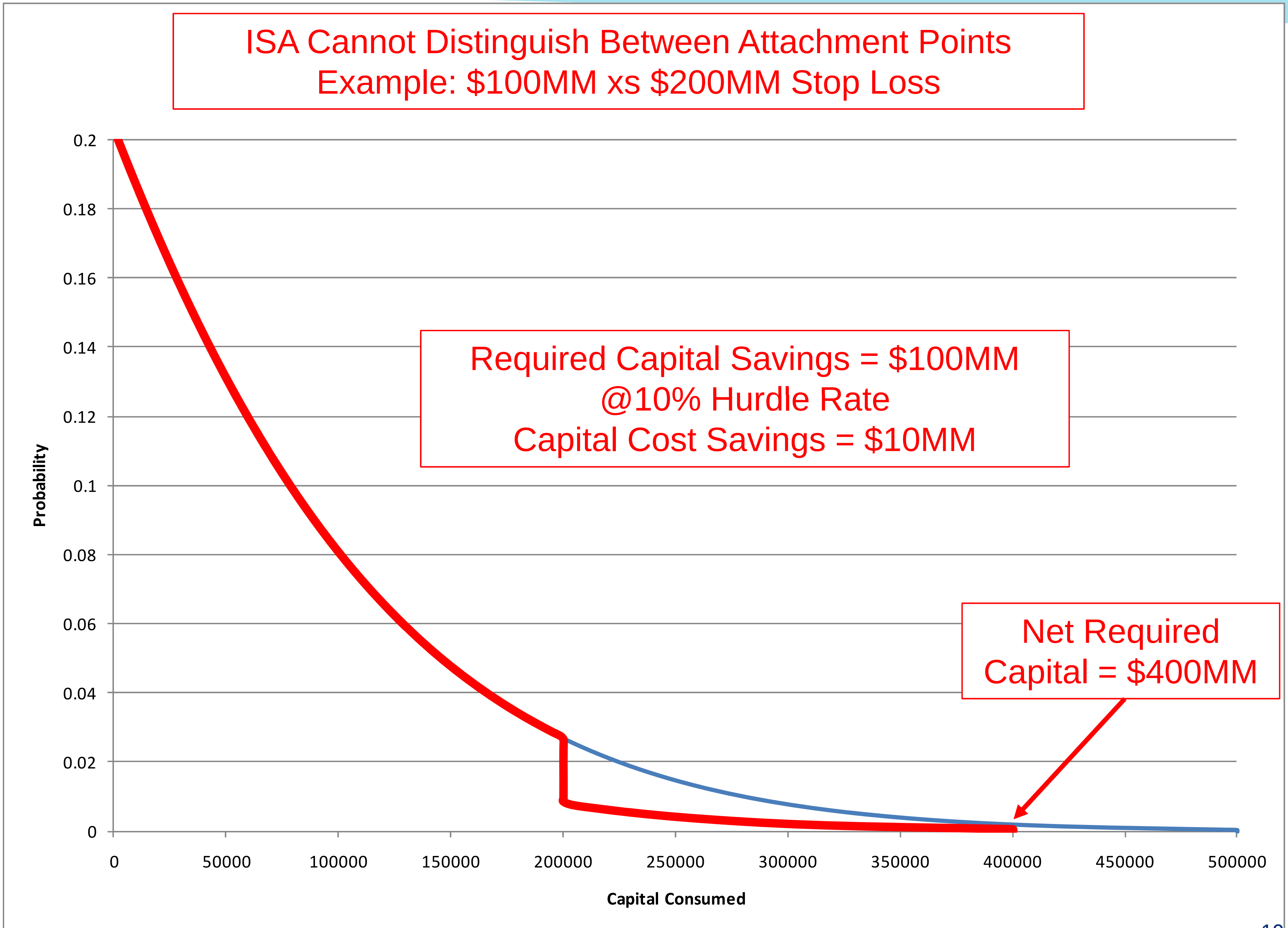
Problem with the ISA

ISA Cannot Distinguish Between Attachment Points
Example: $100MM xs $400MM Stop Loss

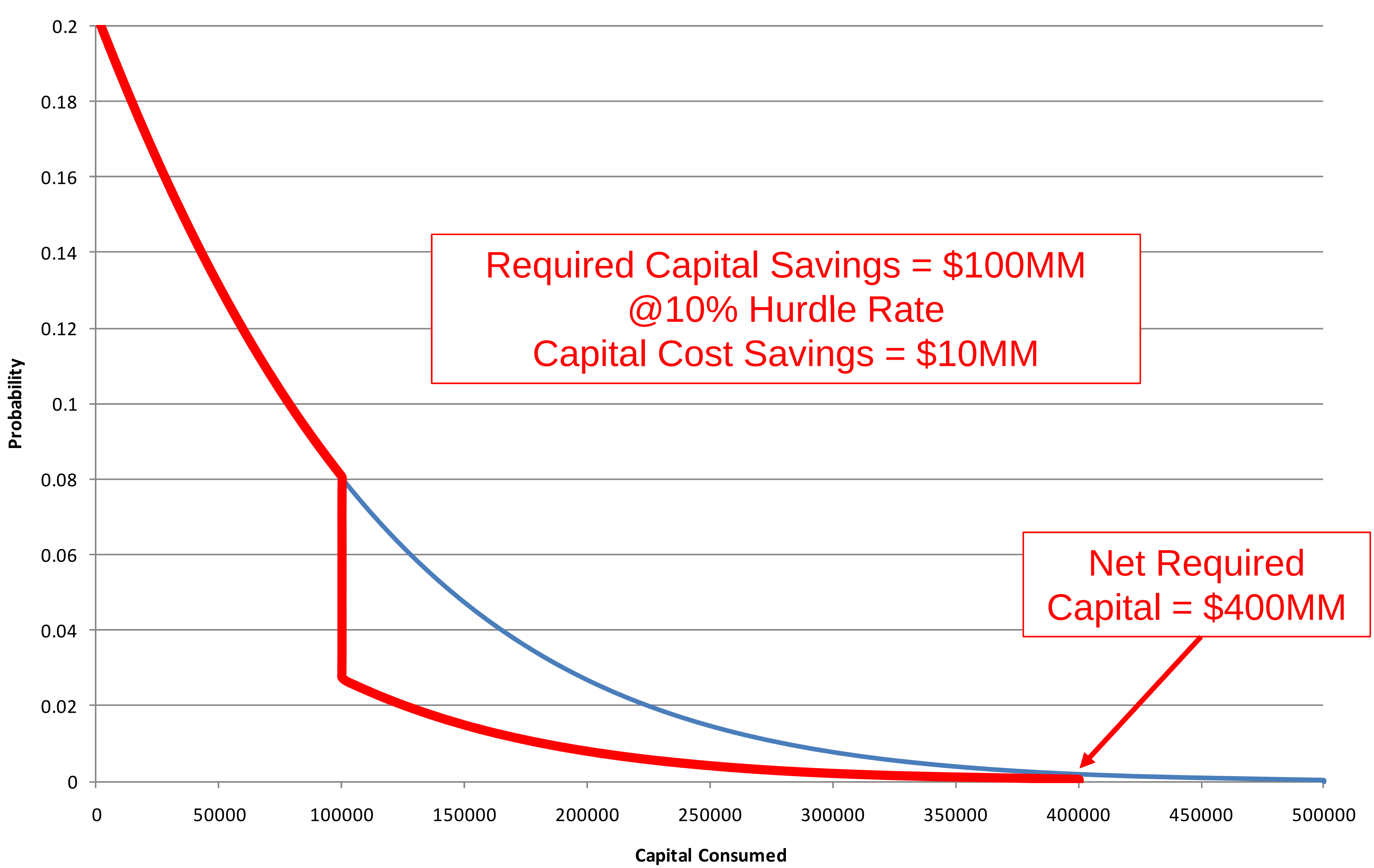


ISA Cannot Distinguish Between Attachment Points
Example: $100MM xs $300MM Stop Loss

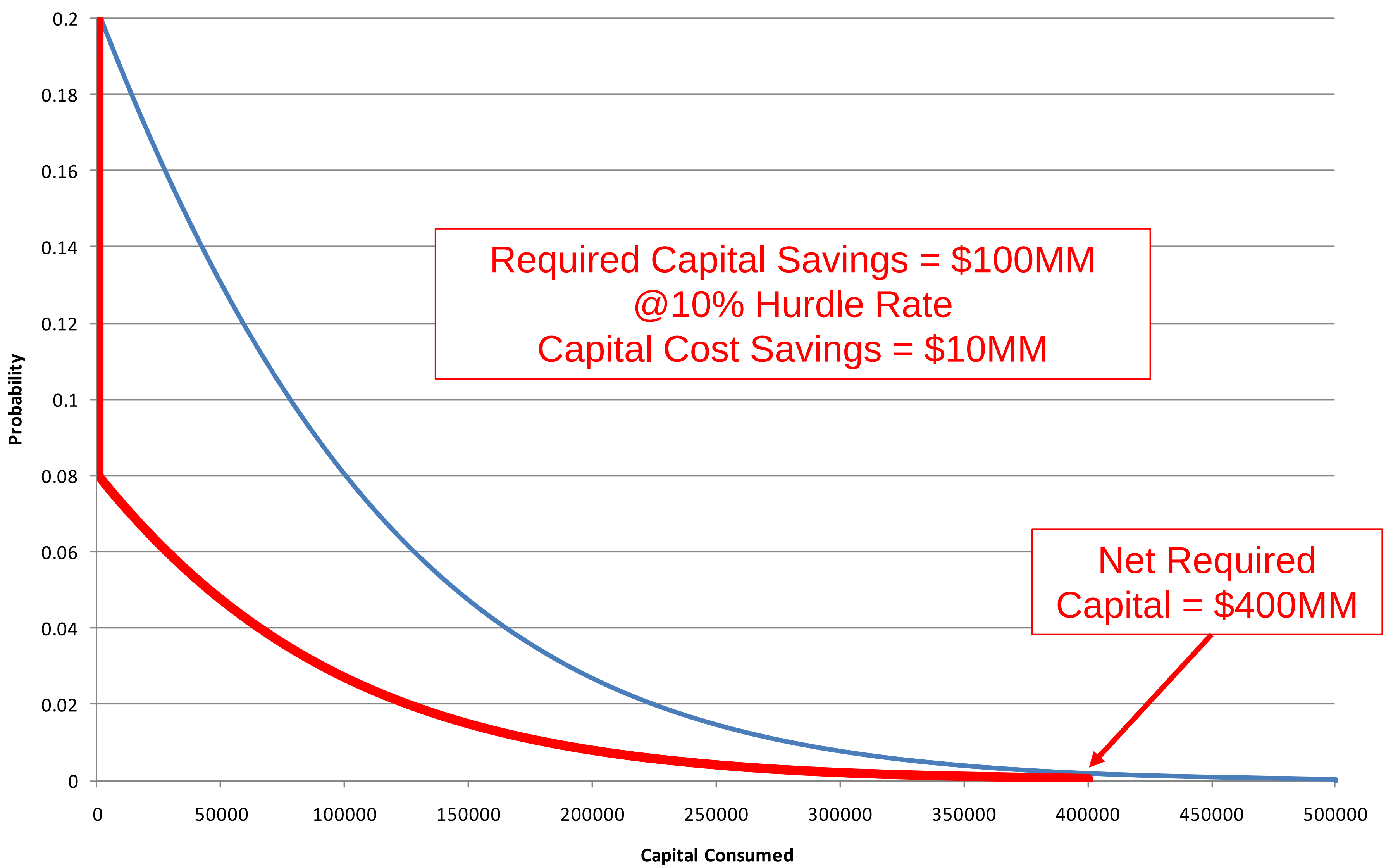



ISA Cannot Distinguish Between Attachment Points
Example: $100MM xs $200MM Stop Loss
Required Capital Savings = $100MM
@10% Hurdle Rate
Capital Cost Savings = $10MM
Net Required
Capital = $400MM
Probability
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
50000
100000
150000
200000
250000
300000
350000
400000
450000
500000
Capital Consumed

ISA Cannot Distinguish Between Attachment Points
Example: $100MM xs $100MM Stop Loss



ISA Cannot Distinguish Between Attachment Points
Example: $100MM xs $0MM Stop Loss



Evaluating Reinsurance Effectiveness
Issues with the ISA

- ISA only measures degree of ruin protection
  - Cannot distinguish between earnings, impairment and ruin benefits
  - This is because ISA cannot account for layer position and attachment priority
- The ISA cannot account for priority because required capital is treated as a single block with no priority
- This means the only way ISA can risk-adjust the cost of capital is to reduce the capital amount, making it an example of a **R**eturn **O**n **R**isk-**A**djusted **C**apital (RORAC) approach.

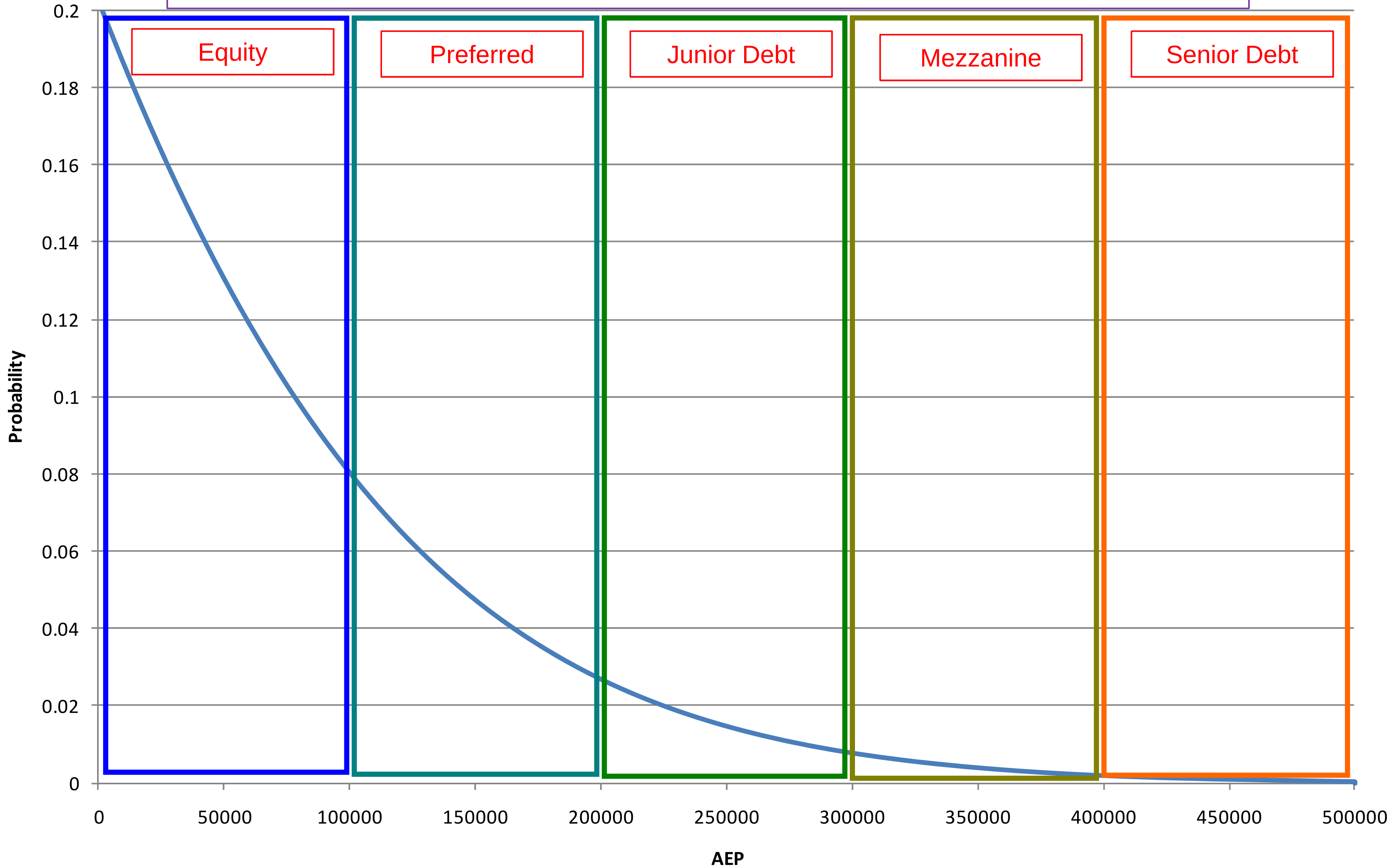
Evaluating Reinsurance Effectiveness
Issues with the ISA

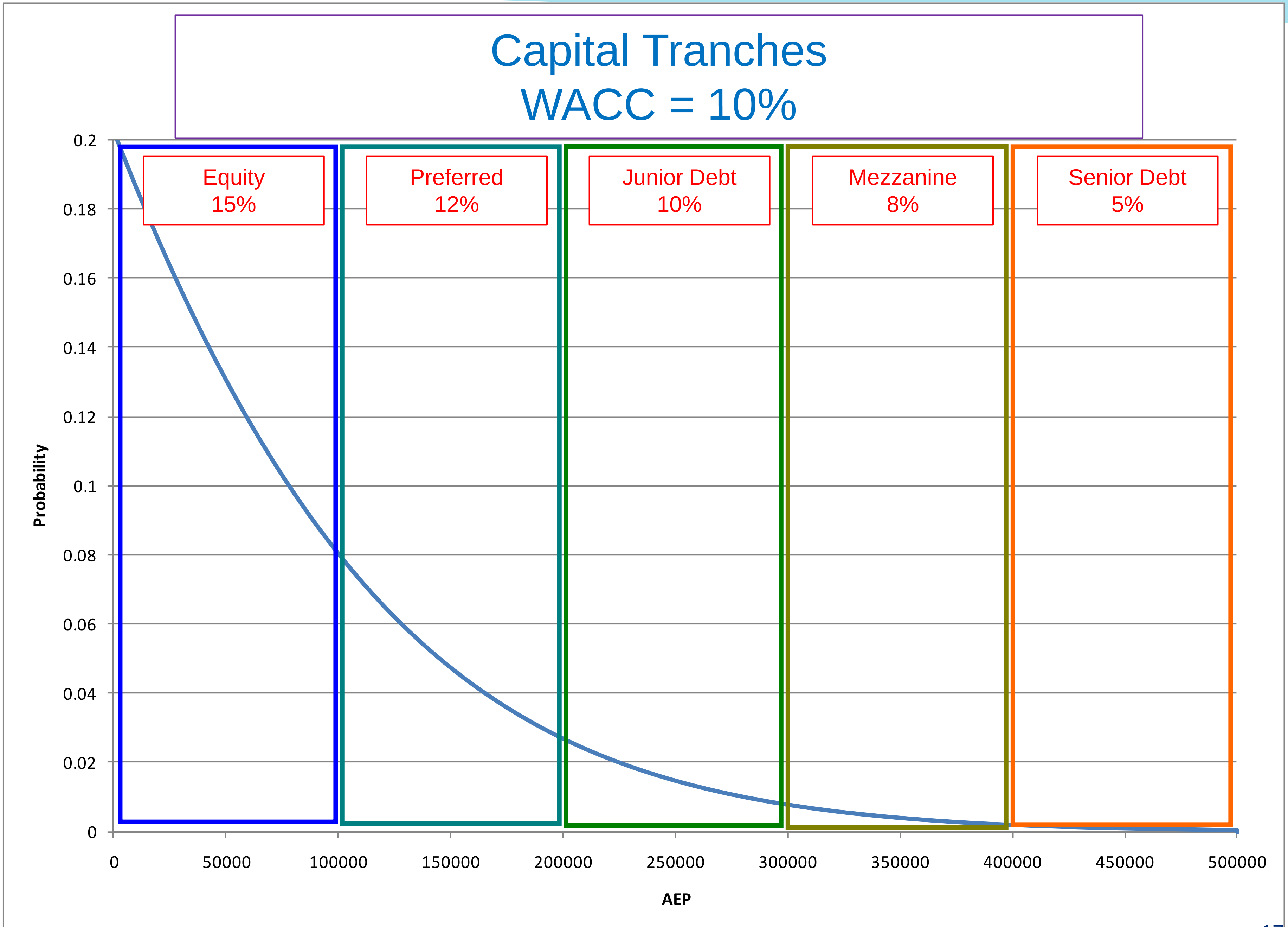
- ISA's RORAC approach implies a very liquid capital structure, more like public companies
- It is at odds with the reality of many insurers (e.g., mutuals, Lloyds syndicates), for whom capital is essentially fixed for the planning period
- You can't calculate RORAC with fixed capital
- You can calculate RAROC –***R***isk-***A***djusted ***R***eturn ***O***n ***C***apital
- But that requires us to impute or attribute a RAROC framework on capital which frankly does not exist to our knowledge
- So we looked at some comparables and facts

Alternative Approach: Capital Tranching
Introduces Priority Within the Capital

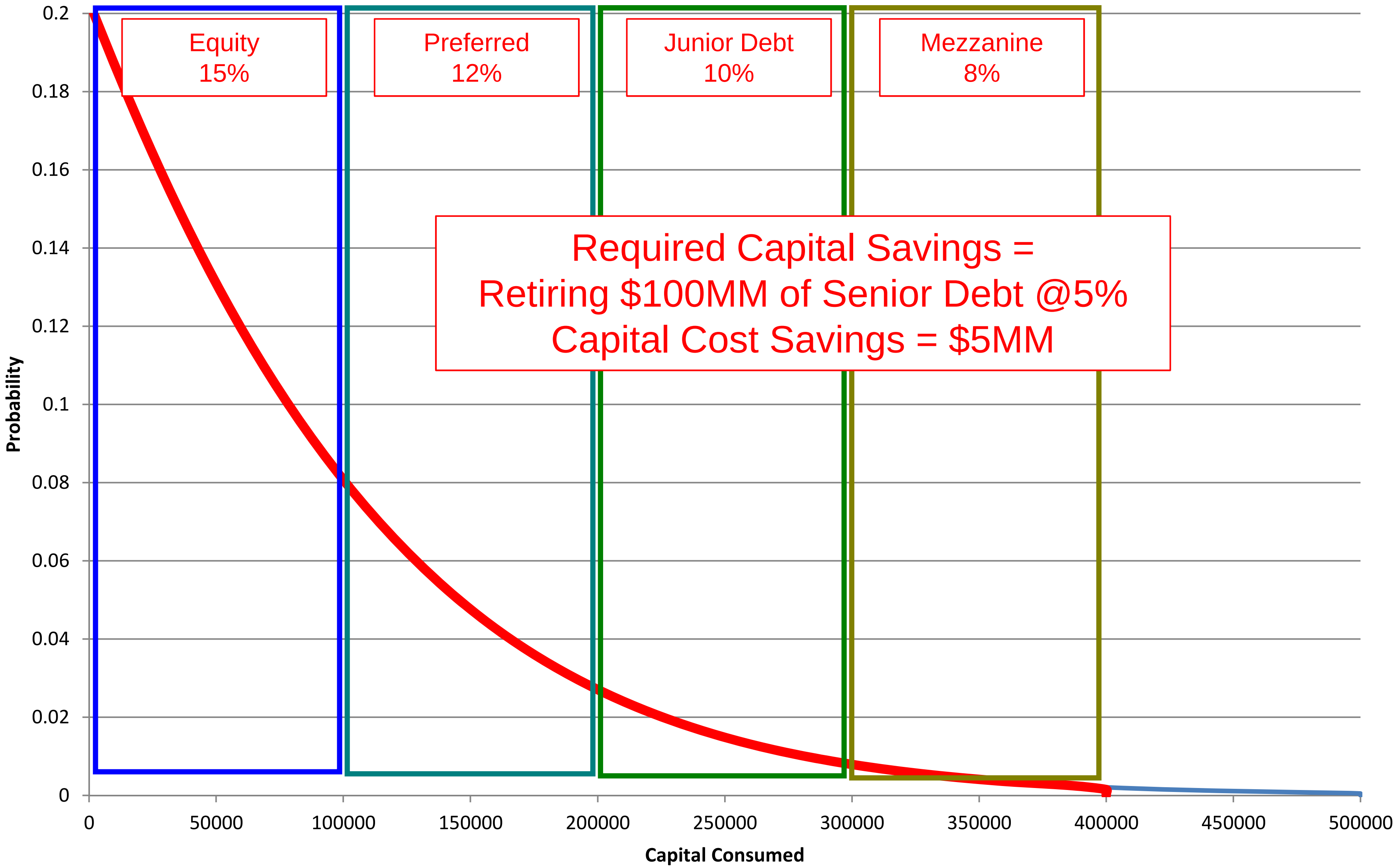
- Guy Carpenter's Capital Tranching[SM] framework introduces a priority order within the capital.
  - The term tranching (from the debt markets) means "layering" or putting in priority order.
- Demarcate required capital into a series of tranches, each with a different hurdle rate.
  - Lower tranches (more likely to be hit and similar to lower rated debt) will have higher hurdle rates than average
  - Higher tranches (less likely to be hit and similar to higher rated debt) will have lower hurdle rates.
- Weighted average hurdle rate over all tranches balances to the same overall hurdle rate used in the ISA.
- By risk-adjusting the hurdle rate, Capital Tranching is an example of a **R**isk-**A**djusted **R**eturn **O**n **C**apital (RAROC) approach

Capital Tranches




Capital Tranches
WACC = 10%
Equity
15%
Preferred
12%
Junior Debt
10%
Mezzanine
8%
Senior Debt
5%
Probability
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
50000
100000
150000
200000
250000
300000
350000
400000
450000
500000
AEP

Capital Tranching Evaluation
100MM xs 400MM Reinsurance

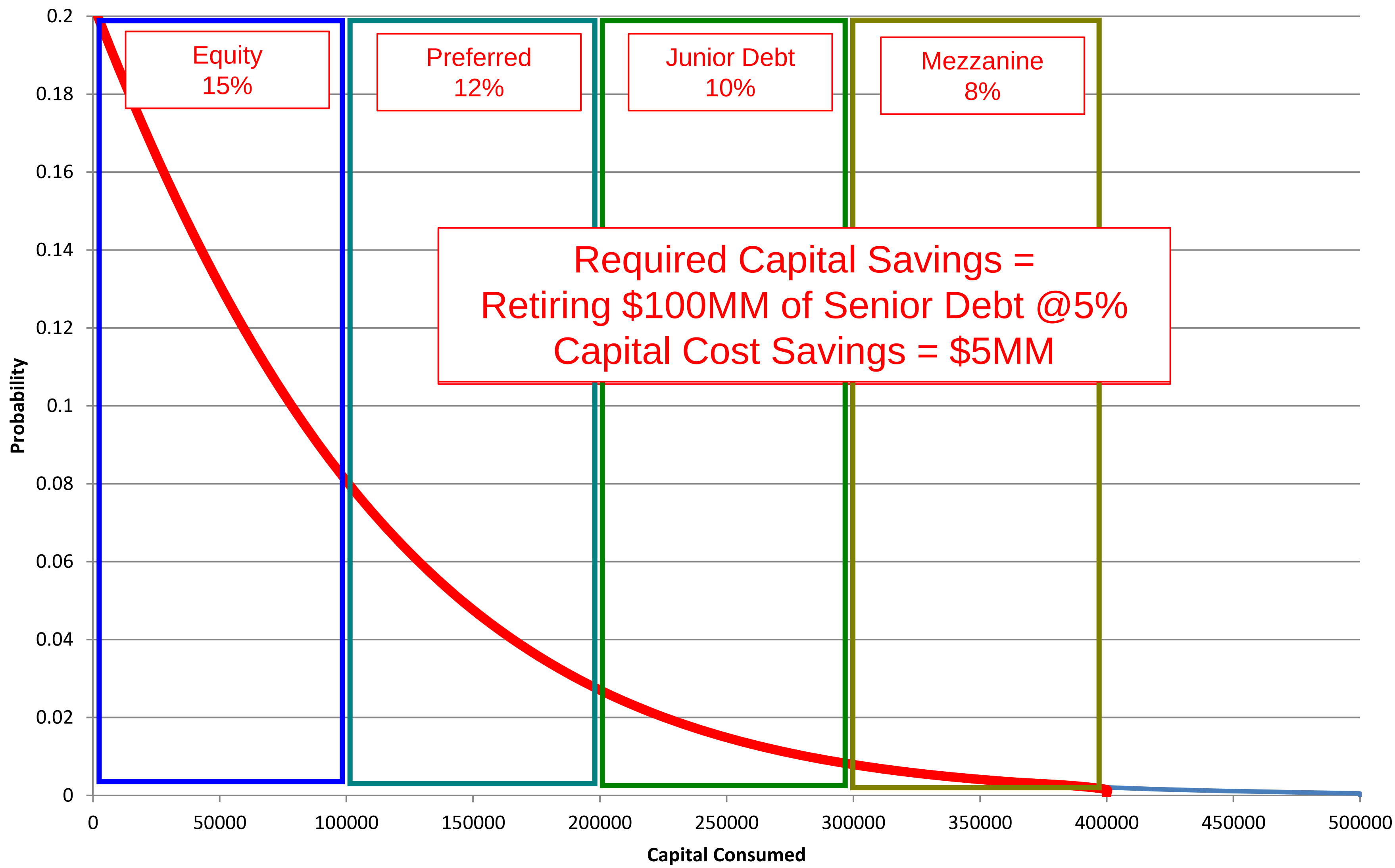


Comparison of 100MM xs 400MM Reinsurance

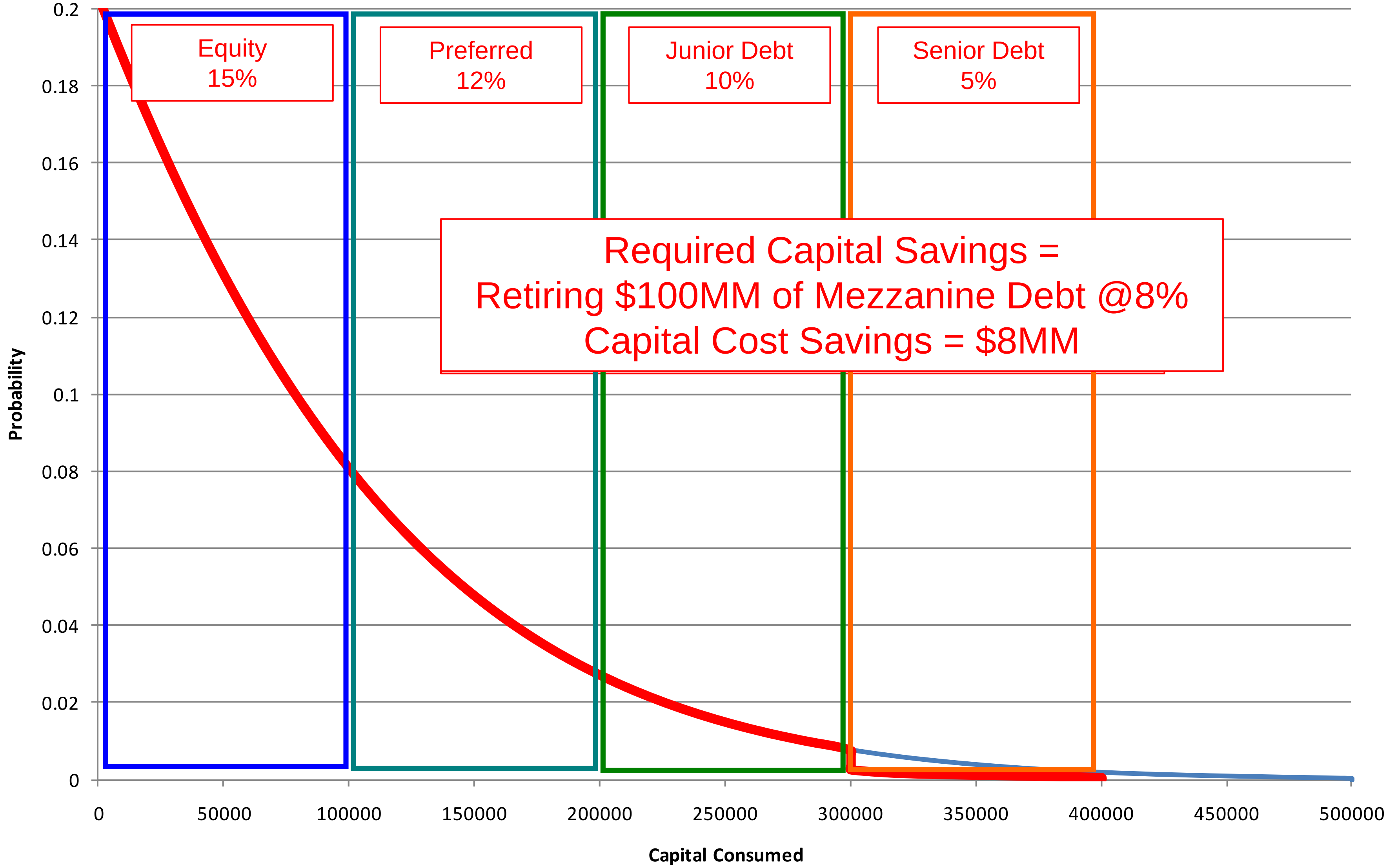
- Assume the Ceded Profit is $8MM
- ISA says we save $10MM in capital costs → **GREEN LIGHT**
- Tranching says we save $5MM → **RED LIGHT**

How Does Tranching Evaluate the Other Layers?

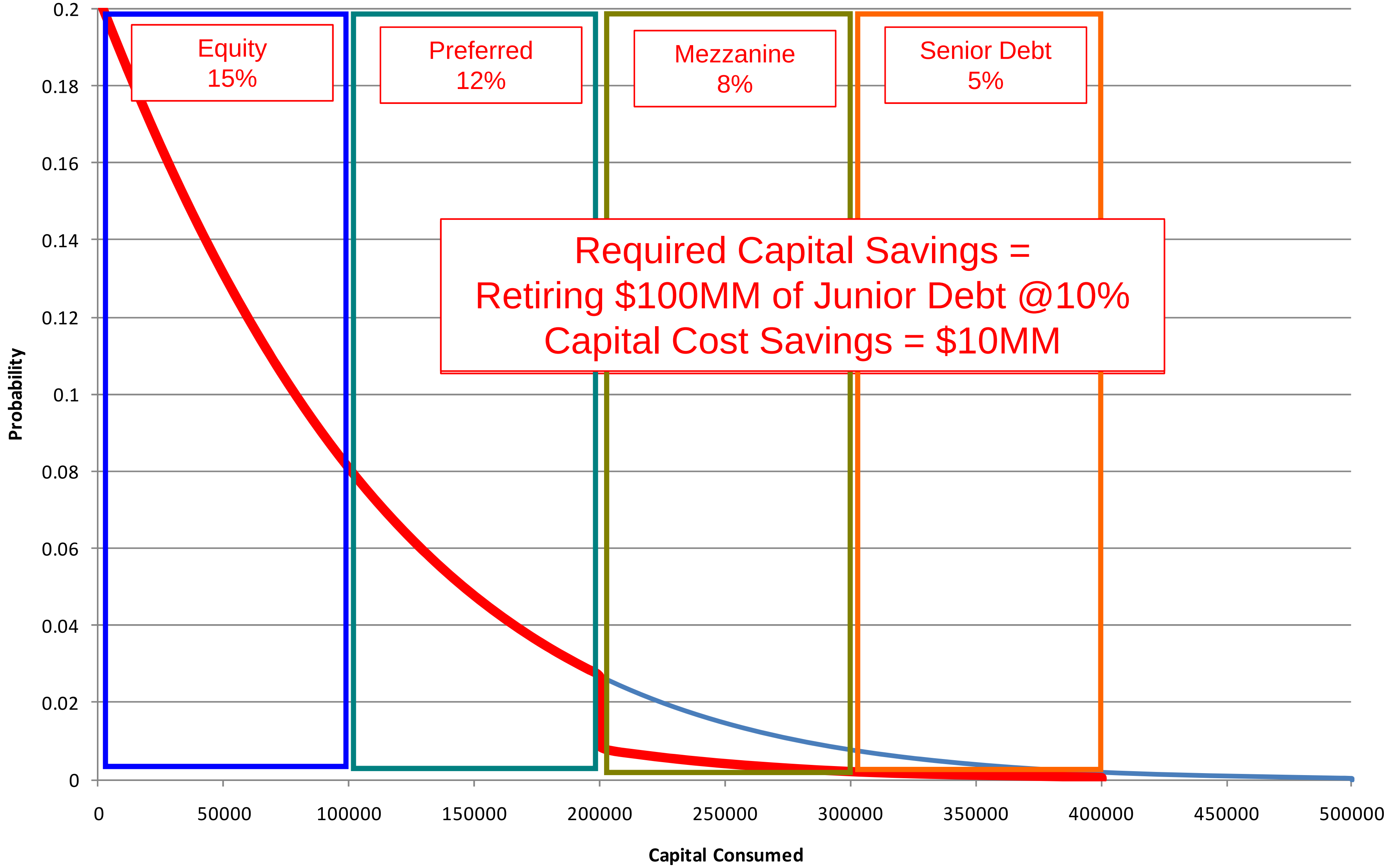
Tranching Can Distinguish Between Attachment Points
Example: $100MM xs $400MM Stop Loss



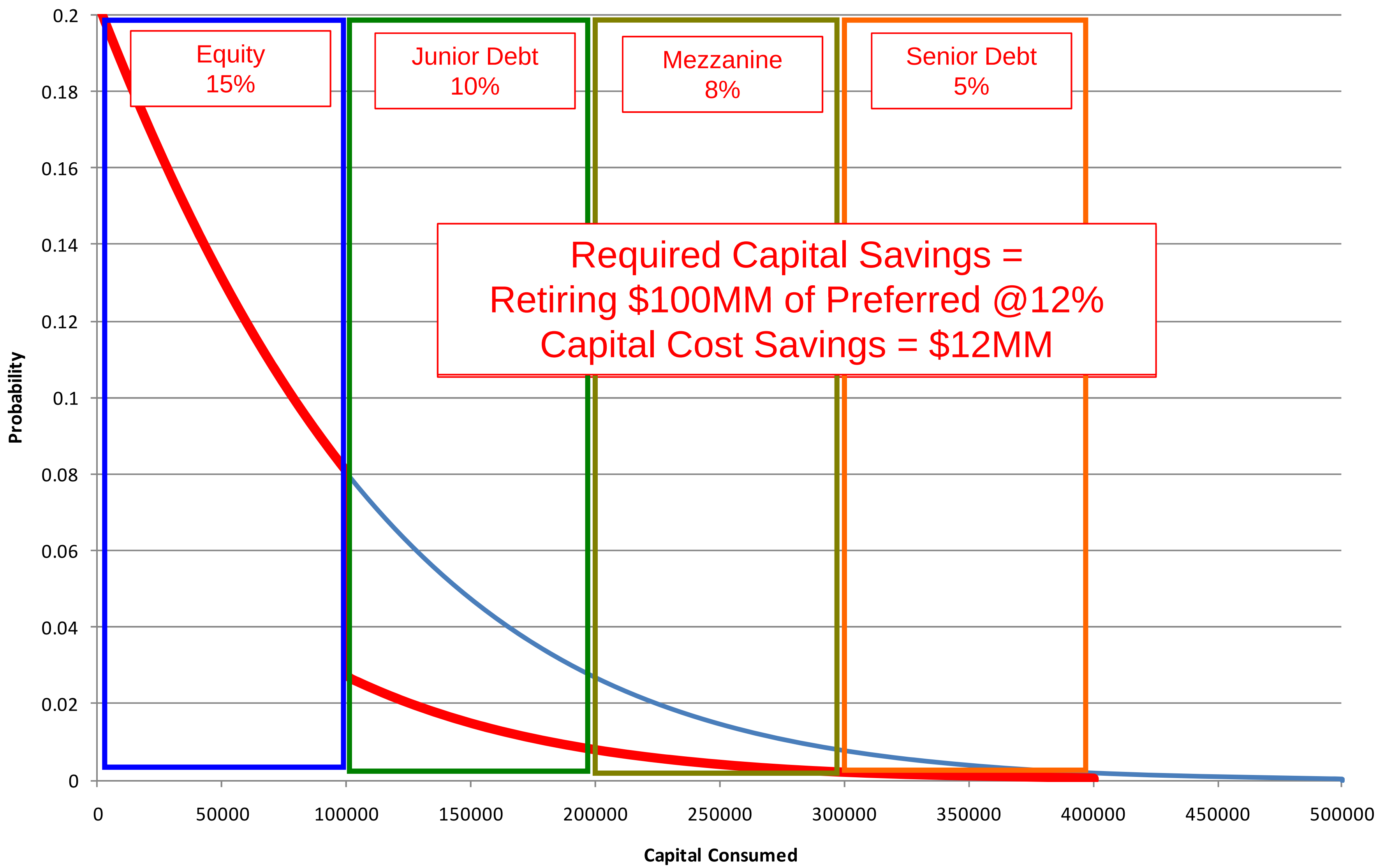
Tranching Can Distinguish Between Attachment Points
Example: $100MM xs $300MM Stop Loss



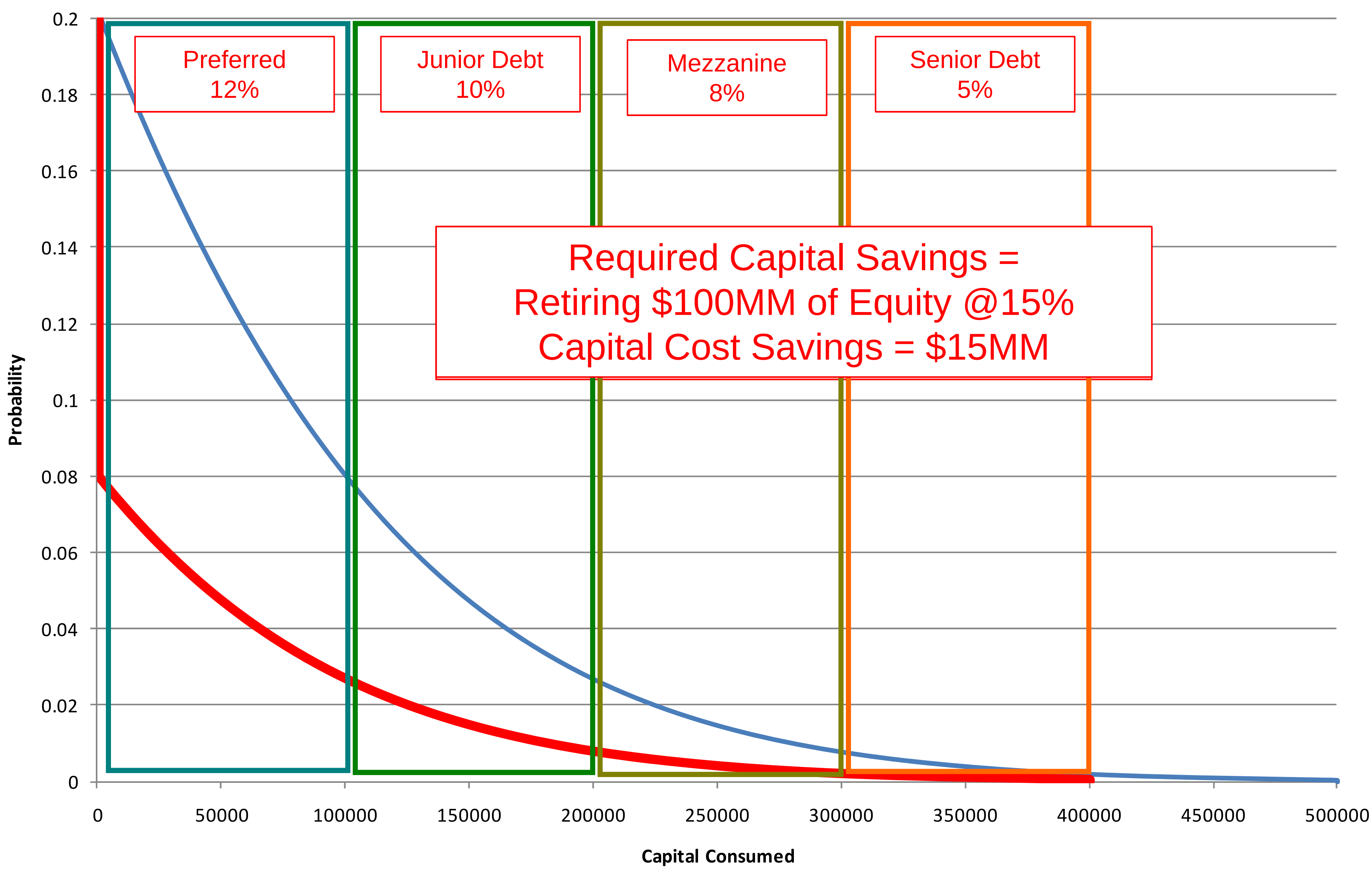
Tranching Can Distinguish Between Attachment Points
Example: $100MM xs $200MM Stop Loss



Tranching Can Distinguish Between Attachment Points
Example: $100MM xs $100MM Stop Loss



Tranching Can Distinguish Between Attachment Points
Example: $100MM xs $0MM Stop Loss



Numerical Example

Simple ISA Example: *Single-Event Collateralized Sidecar Reinsurer*

Table 1 -- Capital Consumption Distribution			
Event	*Prob*	*Cum Prob*	*Capital Consumed*
None	95.0%	95.0%	0
A	1.0%	96.0%	100
B	1.0%	97.0%	200
C	1.0%	98.0%	300
D	1.0%	99.0%	400
E	1.0%	100.0%	500

ISA Example: *Net of Five Different Cat Layers*

Cat Layers 1 – 5 are $100MM limit attaching every $100MM
Beginning with Layer 1 attaching at $0

Table 2 -- Capital Consumption Distribution Gross and Net of Cat Layers						
Event	*Gross*	*Net of Layer 1*	*Net of Layer 2*	*Net of Layer 3*	*Net of Layer 4*	*Net of Layer 5*
None	0	0	0	0	0	0
A	100	0	**100**	**100**	**100**	**100**
B	200	100	100	**200**	**200**	**200**
C	300	200	200	200	**300**	**300**
D	400	300	300	300	300	**400**
E	500	400	400	400	400	400
			Shaded Cells have Net = Gross			

Imputed Costs of Tranches

- Hurdle rate = weighted average cost of tranches
- Highest cost (lowest rated) tranche > average cost > lowest cost (highest rated) tranche
- But how much higher and lower? Major calls this “curvature”
- Debt markets were too thinly traded at the P(Att) we needed
  - C-rated debt, distressed
- We could use catastrophe bonds
- …which are more and more being priced like catastrophe reinsurance layers
- …which are priced consistently with Kreps (1990) = E(L) + % of Std Dev
- So we will use reinsurance prices, calibrated to the overall average cost

Back to the Example

Table 3 -- Capital Tranche Pricing						
	ESL Layers					
	1	2	3	4	5	**TOTAL**
Att	0	100	200	300	400	
Lim	100	100	100	100	100	500
P(Att)	5.00%	4.00%	3.00%	2.00%	1.00%	
Loss on Line	5.00%	4.00%	3.00%	2.00%	1.00%	
Std Dev = SQRT(P*(1-P))	21.79%	19.60%	17.06%	14.00%	9.95%	
Reluctance Factor	42.48%	42.48%	42.48%	42.48%	42.48%	42.48%
Price	$ 14.26	$ 12.32	$ 10.25	$ 7.95	$ 5.23	$ 50.00
ROL	14.26%	12.32%	10.25%	7.95%	5.23%	10.00%

- Assume each layer is binary – either no loss or full limit loss – which means
  - Loss on Line = P(Attaching)
  - Std Dev = Sqrt[P(Att) * (1-P(Att))]
  - Rate on Line = LoL + Std Dev * Reluctance *{Kreps 1990}*

Example Gross Case

Table 3 -- Capital Tranche Pricing						
	ESL Layers					
	1	2	3	4	5	**TOTAL**
Att	0	100	200	300	400	
Lim	100	100	100	100	100	500
P(Att)	5.00%	4.00%	3.00%	2.00%	1.00%	
Loss on Line	5.00%	4.00%	3.00%	2.00%	1.00%	
Std Dev = SQRT(P*(1-P))	21.79%	19.60%	17.06%	14.00%	9.95%	
Reluctance Factor	42.48%	42.48%	42.48%	42.48%	42.48%	42.48%
Price	$ 14.26	$ 12.32	$ 10.25	$ 7.95	$ 5.23	$ 50.00
ROL	14.26%	12.32%	10.25%	7.95%	5.23%	10.00%

- TOTAL column = RAROC = Cost of (Reinsurance) Capital
- Set Reluctance to produce overall ROL of 10%

Example Net of Cat Layer 1

Table 4 -- Capital Tranche Pricing Net of Cat Layer 1						
	ESL Layers					
	1	2	3	4	5	**TOTAL**
Att	0	100	200	300	400	
Lim	100	100	100	100	100	500
P(Att)	4.00%	3.00%	2.00%	1.00%	0.00%	
Loss on Line	4.00%	3.00%	2.00%	1.00%	0.00%	
Std Dev = SQRT(P*(1-P))	19.60%	17.06%	14.00%	9.95%	0.00%	
Reluctance Factor	42.48%	42.48%	42.48%	42.48%	42.48%	
Price	$ 12.32	$ 10.25	$ 7.95	$ 5.23	$ -	$ 35.74
ROL	12.32%	10.25%	7.95%	5.23%	**0.00%**	7.15%

- ESL 5 has P(Att) = 0 → ROL = 0
- Cat Layer 1 **replaced** ESL 1
- ESL {1 – 4} Net = {2 – 5} Gross
- ESL 1 cost $14.26MM
- $50MM – $14.26MM = $35.74MM

Example Net of Cat Layer 2

Table 5 -- Capital Tranche Pricing Net of Cat Layer 2						
	ESL Layers					
	1	2	3	4	5	**TOTAL**
Att	0	100	200	300	400	
Lim	100	100	100	100	100	500
P(Att)	5.00%	3.00%	2.00%	1.00%	0.00%	
Loss on Line	5.00%	3.00%	2.00%	1.00%	0.00%	
Std Dev = SQRT(P*(1-P))	21.79%	17.06%	14.00%	9.95%	0.00%	
Reluctance Factor	42.48%	42.48%	42.48%	42.48%	42.48%	
Price	$ 14.26	$ 10.25	$ 7.95	$ 5.23	$ -	$ 37.68
ROL	14.26%	10.25%	7.95%	5.23%	**0.00%**	7.54%

- Cat Layer 2 **replaced** ESL 2
- ESL 1 Net = Gross
- ESL {2 – 4} Net = {3 – 5} Gross
- ESL 2 cost $12.32MM
- $50MM – $12.32MM = $37.68MM

Stop the Presses (1/2)

Table 6 -- Capital Tranching Evaluation of Cat Layers 1 to 5								
	ESL Layers						*Evaluation*	
	1	2	3	4	5	**TOTAL**	**Capital Cost Savings**	**Price**
Gross	14.26%	12.32%	10.25%	7.95%	5.23%	10.00%		
Net of Cat Layer 1	12.32%	10.25%	7.95%	5.23%	0.00%	7.15%	$ 14.26	$ 14.26
Net of Cat Layer 2	14.26%	10.25%	7.95%	5.23%	0.00%	7.54%	$ 12.32	$ 12.32
Net of Cat Layer 3	14.26%	12.32%	7.95%	5.23%	0.00%	7.95%	$ 10.25	$ 10.25
Net of Cat Layer 4	14.26%	12.32%	10.25%	5.23%	0.00%	8.41%	$ 7.95	$ 7.95
Net of Cat Layer 5	14.26%	12.32%	10.25%	7.95%	0.00%	8.95%	$ 5.23	$ 5.23

- ISA measured identical capital impact of Cat Layers 1 – 5
- Capital Tranching clearly distinguishes among the different Cat Layers

Areas for Future Research

- Methodology for selecting an appropriate Capital Cost Rate, for both stock and mutual companies;
- Case studies using actual reinsurance programs;
- Assessment of consistency of the two approaches with risk aversion (both policyholder and shareholder);
- Consideration of other tranching pricing frameworks, including debt-equivalents and option pricing;
- Integration into franchise-value models such as Major (2011)
  Risk Valuation for Property-Casualty Insurers
  www.variancejournal.org/issues/05-02/124.pdf

Conclusions

<table>
<tr><th colspan="3">Table 7 -- Comparing ISA and Capital Tranching Approaches to Evaluating Reinsurance Effectiveness</th></tr>
<tr><th>Item</th><th>ISA</th><th>Capital Tranching</th></tr>
<tr><td>Input Distribution</td><td colspan="2">Gross and Net Capital Consumption distribution from Internal Capital Model</td></tr>
<tr><td>Required Capital Amount</td><td>Variable (risk-adjusted)</td><td>Fixed</td></tr>
<tr><td>Capital Released</td><td>Change in Required Capital</td><td>N/A</td></tr>
<tr><td>Cost of Capital Rate</td><td>Fixed</td><td>Variable (risk-adjusted)</td></tr>
<tr><td>Capital Cost Savings</td><td>Product of Capital Release and Cost of Capital Rate</td><td>Product of Capital Amount and Change in Cost of Capital Rate</td></tr>
<tr><td>Cost-Effectiveness Evaluation</td><td colspan="2">Ceded Profit Margin < Capital Cost Savings</td></tr>
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