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Andreas Krause

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Outline				

# Insuring default risk

Default rates

Valuing credit default swaps

The relationship to discount rates for risky bonds



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#### Insuring default risk

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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Payment on def	ault			

Credit default swaps make a payment to the buyer if the underlying entity defaults on its obligation

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Payment on def	ault			

- Credit default swaps make a payment to the buyer if the underlying entity defaults on its obligation
- The underlying entity can be companies

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Payment on def	ault			

- Credit default swaps make a payment to the buyer if the underlying entity defaults on its obligation
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- The payment are determined as the losses arising from the default

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- The loss is the amount that the entity does not pay to bondholders

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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# Credit default rate spread

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Credit default rate	e spread			

▶ The buyer has to pay the seller of the credit default swap a premium

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Credit default ra	te spread			

The buyer has to pay the seller of the credit default swap a premium, which is known as the spread

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Credit default r	ate spread			

- The buyer has to pay the seller of the credit default swap a premium, which is known as the spread
- ▶ The spread is paid in regular intervals until the default occurs

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Credit default rate spread

- The buyer has to pay the seller of the credit default swap a premium, which is known as the spread
- The spread is paid in regular intervals until the default occurs
- The total amount the buyer pays will depend on the timing of the default

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Credit default rate spread

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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Hazard rate				

► The probability of a company defaulting in a time interval is assumed to be linear in this time interval: Prob(default in  $[t, t + \Delta t]) = h\Delta t$ 

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- ► The probability of a company defaulting in a time interval is assumed to be linear in this time interval: Prob(default in  $[t, t + \Delta t]) = h\Delta t$
- The probability of default is characterised by the hazard rate

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- The hazard gives the probability of default in a single time period

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Probability of I	not defaulting			

The probability of not defaulting is the complement of defaulting: Prob (no default in  $[t, t + \Delta t]$ ) =  $1 - h\Delta t$ 

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- The time to maturity of the credit default swap is the limit of interest for defaults and we divide this into a number of time periods:  $\tau = N\Delta t$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- The time to maturity of the credit default swap is the limit of interest for defaults and we divide this into a number of time periods:  $\tau = N\Delta t$
- ▶ Defaults are independent over time: Prob (no default until maturity) = (1 - h∆t)<sup>N</sup>

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- $\blacktriangleright$  We now increase the number of time periods,  $N 
  ightarrow \infty$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- ▶ We now increase the number of time periods,  $N \to \infty$ , requiring that the length of a time period reduces,  $\Delta t \to 0$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Default rates

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# Value of fee payments

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Value of fee na	vments			

The spread is paid continuously until the maturity of the credit default swap

$$\blacktriangleright V_{\mathsf{Fee}} = \int_0^\tau s \qquad ds$$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Value of fee pay	vments			

The spread is paid continuously until the maturity of the credit default swap, as long as the entity has not defaulted

$$\blacktriangleright V_{\mathsf{Fee}} = \int_0^\tau s \qquad e^{-h(t-\tau)} dt$$
Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Value of fee pa	yments			

- The spread is paid continuously until the maturity of the credit default swap, as long as the entity has not defaulted
- ► The spread payment needs to be discounted to its present value
- $\blacktriangleright V_{\text{Fee}} = \int_0^\tau s e^{-r(t-\tau)} e^{-h(t-\tau)} dt$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Value of fee pa	yments			

- The spread is paid continuously until the maturity of the credit default swap, as long as the entity has not defaulted
- ▶ The spread payment needs to be discounted to its present value

$$V_{\text{Fee}} = \int_0^\tau s e^{-r(t-\tau)} e^{-h(t-\tau)} dt$$
$$= s \int_0^\tau e^{-(r+h)(t-\tau)} dt$$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Value of fee payr	nents			

- The spread is paid continuously until the maturity of the credit default swap, as long as the entity has not defaulted
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$$V_{\text{Fee}} = \int_0^\tau s e^{-r(t-\tau)} e^{-h(t-\tau)} dt$$
$$= s \int_0^\tau e^{-(r+h)(t-\tau)} dt$$
$$= \frac{s}{r+h} \left( 1 - e^{-(r+h)\tau} \right)$$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Contingent paym	nent			

The seller pays the amount not recovered from the obligation of the entity, if the entity defaults

$$\blacktriangleright V_{\mathsf{Pay}} = (1 - R)$$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- The seller pays the amount not recovered from the obligation of the entity, if the entity defaults
- The entity can default at a specific point of time

• 
$$V_{\mathsf{Pay}} = (1 - R) \int_0^\tau h \, dt$$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- The seller pays the amount not recovered from the obligation of the entity, if the entity defaults
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- The seller pays the amount not recovered from the obligation of the entity, if the entity defaults
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$$V_{\text{Pay}} = (1 - R) \int_0^\tau e^{-r(t-\tau)} h e^{-h(t-\tau)} dt$$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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- The seller pays the amount not recovered from the obligation of the entity, if the entity defaults
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► 
$$V_{\text{Pay}} = (1 - R) \int_0^\tau e^{-r(t-\tau)} h e^{-h(t-\tau)} dt$$
  
=  $(1 - R) h \int_0^\tau e^{-(r+h)(t-\tau)} dt$ 

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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=  $(1 - R) h \frac{1 - e^{-(r+h)\tau}}{r+h}$ 

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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=  $(1 - R) \frac{h}{s} V_{\text{Fee}}$ 

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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# The CDS spread

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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The CDS spread				

The credit default swap is priced fairly if the payments made by the buyer equal the payments they receive from the seller

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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The CDS spread				

- The credit default swap is priced fairly if the payments made by the buyer equal the payments they receive from the seller
- $\blacktriangleright V_{\mathsf{Fee}} = V_{\mathsf{Pay}}$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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The CDS spread				

The credit default swap is priced fairly if the payments made by the buyer equal the payments they receive from the seller

$$\blacktriangleright V_{\mathsf{Fee}} = V_{\mathsf{Pay}}$$

 $\Rightarrow s = (1 - R) h$ 

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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The CDS spread				

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- $\blacktriangleright \ V_{\mathsf{Fee}} = V_{\mathsf{Pay}}$
- $\Rightarrow s = (1 R) h$
- The spread reflects the probability of default

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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The value of a risk	xy zero bond			

A zero bond does not make coupon payments



A zero bond does not make coupon payments, but only repays its face value at maturity



- A zero bond does not make coupon payments, but only repays its face value at maturity
- Its value is the present value of this future repayment



 $e^{-r\tau}$ 



- A zero bond does not make coupon payments, but only repays its face value at maturity
- Its value is the present value of this future repayment
- If the entity does not default before maturity, it will make a full repayment

$$\blacktriangleright B = (e^{-h\tau}) e^{-r\tau}$$

- A zero bond does not make coupon payments, but only repays its face value at maturity
- Its value is the present value of this future repayment
- If the entity does not default before maturity, it will make a full repayment
- ▶ If the entity does default before maturity, it will only make a partial repayment
- $\blacktriangleright B = \left(e^{-h\tau} + \left(1 e^{-h\tau}\right)R\right)e^{-r\tau}$

- A zero bond does not make coupon payments, but only repays its face value at maturity
- Its value is the present value of this future repayment
- ▶ If the entity does not default before maturity, it will make a full repayment
- ▶ If the entity does default before maturity, it will only make a partial repayment

► 
$$B = (e^{-h\tau} + (1 - e^{-h\tau})R)e^{-r\tau}$$
  
=  $e^{-(r+h)\tau}(1 - R) + e^{-r\tau}R$ 

- A zero bond does not make coupon payments, but only repays its face value at maturity
- Its value is the present value of this future repayment
- ▶ If the entity does not default before maturity, it will make a full repayment
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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$$= e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} e^{h\tau} R$$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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$$= e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} e^{h\tau} R$$
  

$$\approx e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} (1+h\tau) R$$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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$$= e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} e^{h\tau} R$$
  

$$\approx e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} (1+h\tau) R$$
  

$$= e^{-(r+h)\tau} (1+hR\tau)$$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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$$\begin{split} &= e^{-(r+h)\tau} \left( 1-R \right) + e^{-(r+h)\tau} e^{h\tau} R \\ &\approx e^{-(r+h)\tau} \left( 1-R \right) + e^{-(r+h)\tau} (1+h\tau) R \\ &= e^{-(r+h)\tau} \left( 1+hR\tau \right) \\ &\approx e^{-(r+h)\tau} e^{hR\tau} \end{split}$$

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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$$= e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} e^{h\tau} R$$
  

$$\approx e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} (1+h\tau) R$$
  

$$= e^{-(r+h)\tau} (1+hR\tau)$$
  

$$\approx e^{-(r+h)\tau} e^{hR\tau}$$
  

$$= e^{-(r+h(1-R))\tau}$$

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$$= e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} e^{h\tau} R$$
  

$$\approx e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} (1+h\tau) R$$
  

$$= e^{-(r+h)\tau} (1+hR\tau)$$
  

$$\approx e^{-(r+h)\tau} e^{hR\tau}$$
  

$$= e^{-(r+h(1-R))\tau}$$
  

$$= e^{-(r+s)\tau}$$
Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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# CDS spreads as measuring bond risks

$$= e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} e^{h\tau} R$$
  

$$\approx e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} (1+h\tau) R$$
  

$$= e^{-(r+h)\tau} (1+hR\tau)$$
  

$$\approx e^{-(r+h)\tau} e^{hR\tau}$$
  

$$= e^{-(r+h(1-R))\tau}$$
  

$$= e^{-(r+s)\tau}$$

 $\Rightarrow\,$  The discount for a risky bond is the risk-free rate adjusted by the spread

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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## CDS spreads as measuring bond risks

$$= e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} e^{h\tau} R$$
  

$$\approx e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} (1+h\tau) R$$
  

$$= e^{-(r+h)\tau} (1+hR\tau)$$
  

$$\approx e^{-(r+h)\tau} e^{hR\tau}$$
  

$$= e^{-(r+h(1-R))\tau}$$
  

$$= e^{-(r+s)\tau}$$

⇒ The discount for a risky bond is the risk-free rate adjusted by the spread
▶ The spread of credit default swaps represents the risk of the bond

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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## CDS spreads as measuring bond risks

$$= e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} e^{h\tau} R$$
  

$$\approx e^{-(r+h)\tau} (1-R) + e^{-(r+h)\tau} (1+h\tau) R$$
  

$$= e^{-(r+h)\tau} (1+hR\tau)$$
  

$$\approx e^{-(r+h)\tau} e^{hR\tau}$$
  

$$= e^{-(r+h(1-R))\tau}$$
  

$$= e^{-(r+s)\tau}$$

⇒ The discount for a risky bond is the risk-free rate adjusted by the spread
▶ The spread of credit default swaps represents the risk of the bond

Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk

Default rates

Valuing credit default swaps

The relationship to discount rates for risky bonds



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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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Insuring default risk	Default rates	Valuing CDS	Risky bonds	Summary
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