Constant Proportion Debt Obligations
(CPDOs)

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Outline

What is a CPDO?

- A CPDO is a leveraged credit investment strategy with the aim of paying high coupons (100-200bp above Libor rate) while investing in investment grade credit
- Asset side: money market account + leveraged credit exposure via index default swaps
- Risky exposure is adjusted dynamically to generate enough income to meet liabilities and to cover for potential losses
- Leverage mechanism:
  - Increasing leverage if losses incurred
  - Decreasing leverage if shortfall reduced
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A new approach

- Studies by rating agencies:
  High-dimensional model for the joint transition of ratings and spreads for all names in the underlying portfolio
- A new approach: Top-down model
  - Credit portfolio modeled in terms of its default order statistic
  - Dependence among names introduced at the aggregate level
  - Possible to study essential risk factors of CPDO strategy
  - Top-down approach allows an assessment of default probabilities, loss distribution and other tail risk measures

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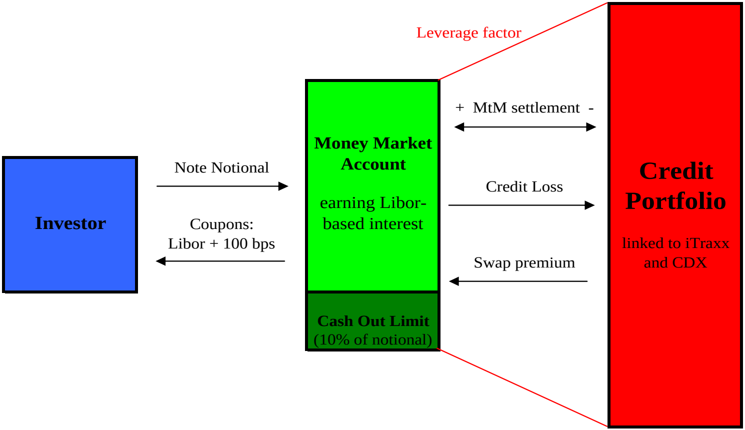
Cashflow diagram



Description

- CA_t: Value of money market account
  V_t: CPDO portfolio value (CA_t + value of index default swaps)
  Coupons: $c_{t_l} = \Delta t_l \big(L(t_{l-1}, t_l) + \delta \big)$
  Coupon dates **CD** $:= \{ t_l \le T \mid l = 1, 2, .. \}$
- *Target value*:

$$TV_t = e^{-r(T-t)} + \sum_{t_l \in \mathbf{CD} \cap [t,T]} c_{t_l} e^{-r(t_l - t)}$$

- *Cash in*: If $V_t \ge TV_t$, liquidate swap contracts
- *Cash out*: If $V_t \le 0.1$, default on remaining coupons and principal note. Recovery $= V_t$
- Expiry time T: If $V_T \le 1$, default on principal. Recovery $= V_T$

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Leverage rule

- Risky exposure: Leveraged position in T^I-year portfolio credit default swaps.
  Swap spread $S(t, T^I)$, swap premium income $P_t(S)$
- Target leverage:

$$m_t = \beta \frac{TV_t - V_t}{P_t(S(t, T^I))}$$

- Roll dates: Downgraded names in underlying index replaced
- Leverage rule:
  - Actual leverage $\bar{m}_t$ set equal to target leverage m_t on roll dates
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- Spread risk
  - affecting mark-to-market gains/losses and spread income
- Default risk
  - affecting frequency of credit events
- Interest rate risk
  - affecting coupons and interest earnings, assumed constant
- Liquidity risk
  - affecting gains/losses from liquidation of swaps, ignored
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1-factor top-down model for portfolio default intensity

- Number of defaults in underlying portfolio up to time t: N_t
  (N_t) has intensity (λ_t^P) wrt. to physical measure P.
- Default dates: τ_i is the i'th default in underlying portfolio,

$$\tau_i = \inf\left\{ t > \tau_{i-1} \middle| \int_{\tau_{i-1}}^{t} \lambda_s^P ds \geq E_i \right\}$$

  for $(E_i)_{i=1,..,N^I}$ i.i.d. exponentially distributed $E_i \sim \exp(1)$
- Portfolio loss: $L_t = \frac{(1-R)}{N^I} N_t$

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T^I-year index swap spread

- Q pricing measure: $\lambda^Q = \vartheta \lambda^P$, ϑ constant
- Default leg: $D_t = E_t^Q \left[\int_t^{T^I} e^{-r(s-t)} dL_s \right]$
  Premium leg:
  $$P_t(S) = S \sum_{t_l \in \mathbf{CD} \cap [t, T^I]} e^{-r(t_l - t)} \Delta t_l \left(1 - \frac{E_t^Q[N_{t_l}]}{N^I} \right) = S\, T_D^{\text{swap}}(t)$$
  Swap spread $S(t, T^I)$ set such that $P_t\left(S(t, T^I)\right) = D_t$
- Assume λ^Q follows a CIR process:
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Index roll: Replacing names in underlying portfolio

- Downgraded names are removed from the index every 6 months and replaced by names with lower default probability
  $\Rightarrow$ downward jump in index default intensity
- Modeled as a proportional jump in the intensity with two possible jump sizes $\{l_1, l_2\}$
- Index roll results in downward jump in swap spread
  $\Rightarrow$ loss when liquidating swaps on roll dates
- Index roll has an instant **harmful** effect on the CPDO
- Long run positive effect from lower default risk

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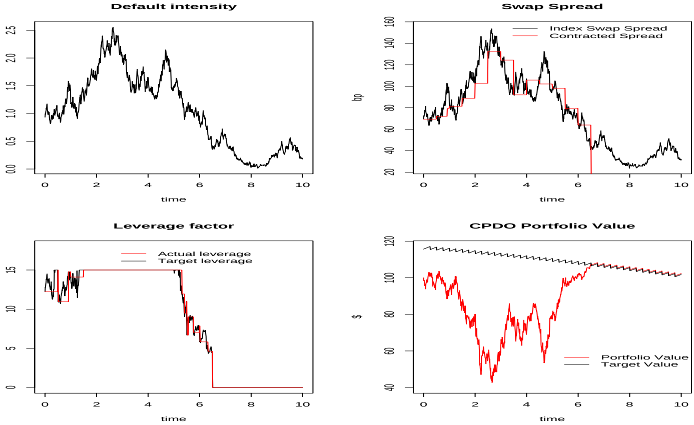
Simulated paths



Simulation results

A fictive setup:

- CPDO paying 200bp spread, 10 years to maturity, $M = 15$ and $\beta = 2$
- Default intensity: λ^Q CIR process with parameters $\theta = 2.8$, $\kappa = 0.2$ and $\sigma = 0.9$. $\lambda^Q = \vartheta\lambda^P$ with $\vartheta = 3$
  $\Rightarrow$ Spread around 70bp and 6.8 defaults in portfolio over 10 years
- Roll over effect: $\{l_1, l_2\} = \{0.2, 0.05\}$
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Performance:

- Probability of default (10 years): 2.5%
  Corresponding to A rating for principal note
- Cash out probability: 0.7%
  Corresponding to AAA rating for coupon payments
- Expected shortfall (99% level): 75% of note notional
- Loss given default: 34% of note notional

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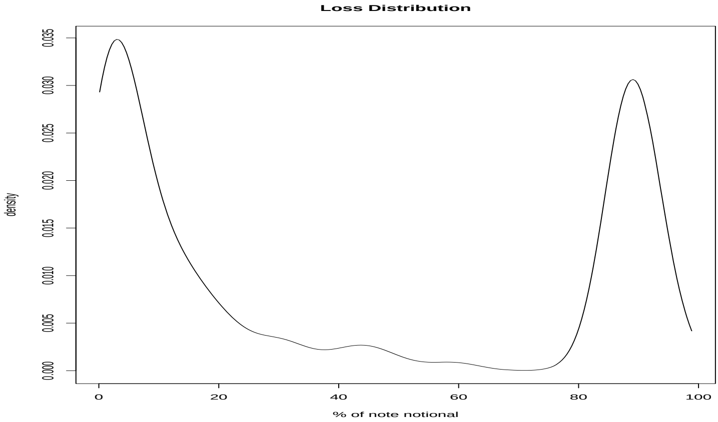
Loss distribution



Sensitivity analysis

- Risk premium ϑ determines level of spread premium income relative to credit losses: Higher ϑ improves performance
- Long term mean of intensity θ sets level of spread income and frequency of credit events: Higher θ improves CPDO performance.
- Mean reversion speed κ determines size of possible spread widening: Higher κ improves CPDO performance.
- Index roll has a significant overall negative effect
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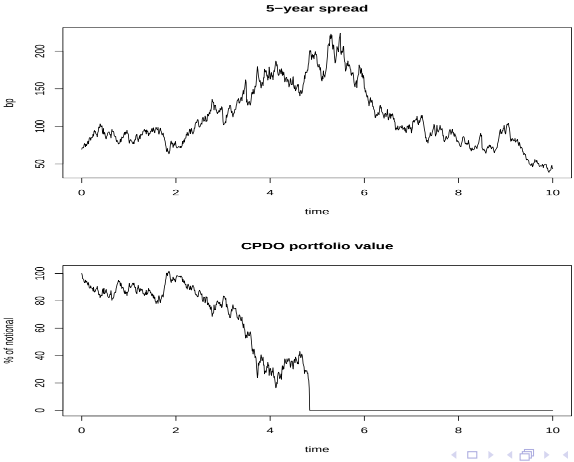
Worst case scenario: Continued spread widening



Concluding remarks

- Our 1-factor top-down model allows for assessment of default probabilities, loss distributions and tail risk measures for CPDO strategy
- CPDO performance is not completely described by probability of default, should be complemented by e.g. expected shortfall
- CPDO performance sensitive to parameter specification
- CPDOs highly exposed to scenarios of spread widening

- Future research:
  - Quantify rating transition probabilities