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Derivative Investments

2017 CFA二级知识框架图

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PRICING AND VALUATION OF FORWARD COMMITMENTS

Pricing And Valuation Of Forward And Futures

price —原理→ ***Limits to Arbitrage*** **no-arbitrage principle** ➡ Cash-and-Carry Arbitrage ★ / Reverse Cash-and-Carry Arbitrage ★

⬇ Price vs. Value ★★

Equity Forward VS. Futures

Futures只求Pricing

Non-dividend Paying Stock

$$FP = S_0 \times (1+R_f)^T$$

$$V_{long} = S_t - \frac{FP}{(1+R_f)^{T-t}}$$

Dividend-paying Stock

$$FP = (S_0 - PVD_0) \times (1+R_f)^T$$

$$V_{long} = S_t - PVD_t - \frac{FP}{(1+R_f)^{T-t}}$$

Equity Index

$$FP = S_0 \times e^{(R_f^c - \delta^c)\times T}$$ → $R_f^c = \ln(1+R_f)$

$$V_{long} = \left(\frac{S_t}{e^{\delta^c \times (T-t)}}\right) - \left(\frac{FP}{e^{R_f^c \times (T-t)}}\right)$$

Bond Forward VS. Futures

T-bill (Zero-coupon Bond)

$$FP = S_0 \times (1+R_f)^T$$

$$V_{long} = S_t - \frac{FP}{(1+R_f)^{T-t}}$$

Forward On Coupon Bond

$$FP = (S_0 - PVC_0) \times (1+R_f)^T$$

$$V_{long} = (S_t - PVC_t) - \frac{FP}{(1+R_f)^{T-t}}$$

T-bond Futures

概念→CTD, CF, AI ★

$$FP = (Clean\ price - PVC) \times (1+R_f)^T$$

$$FP = (\text{full price}) \times (1+R_f)^T - AI_T - FVC$$

$$QFP = \frac{FP}{CF} = \left[(\text{full price}) \times (1+R_f)^T - AI_T - FVC\right]\left(\frac{1}{CF}\right)$$

Interest Rate Forward

基本概念

FRA

- LIBOR
- Euribor
- EuroDollar
- FRAs

- FRA定义★ → *long position →Borrow*; *Short position →lend*
- FRA期限
- 报价★ Example 3×9FRA

Payoff计算★★

Price vs. Value ★★

概念

$$(1+L_m \times m/360)\ (1+FR \times n/360) = (1+L_{m+n} \times (m+n)/360)$$

Currency Forward VS. Futures

$$FP = S_0 \times \frac{(1+R_D)^T}{(1+R_F)^T}$$

$$FP = S_0 \times e^{(R_D^c - R_F^c)\times T}$$

$$V_{long} = \frac{S_t}{(1+R_F)^{T-t}} - \frac{FP}{(1+R_D)^{T-t}}$$

$$V_{long} = \left(\frac{S_t}{e^{R_F^c \times (T-t)}}\right) - \left(\frac{FP}{e^{R_D^c \times (T-t)}}\right)$$

Pricing And Valuation Of Swap Contracts

interest rate swaps ➡
估值★★

Price→ $C = \frac{1 - B_n}{B_1 + B_2 + \cdots + B_n}$ 求Swap rate，discount factor会算

Value→ $V_{swap}(X) = B_{flt} - B_{fix}$ 考法很常规，多做例题即可

Currency swaps ➡
估值★★

Price→ 各自币种按照利率互换方法求Swap rate，只对固定利率一方定价

Value→ 练习固定换固定，浮动换固定，及浮动换浮动即可

Equity swaps ➡
估值★★

Price→ 按照利率互换方法求Swap rate

Value→ 练习equity换固定跟equity换浮动利率

三种互换的Credit risk特征★

Contract	t=t	t=T
Interest Rate Swap	High	Low
Equity Swap	High	Low
Currency Swap	High	higher

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VALUATION OF CONTINGENT CLAIMS

Valuation Of Option Contract

Put-call parity ★★

$$C_t + \frac{X}{(1+R_f)^{T-t}} = P_t + S_t$$

考法1：计算★

考法2： synthetic instruments ★★

考法3：套利★

Fiduciary Call=Protective Put

Put call parity for options on forwards and futures

$$C_0 + \frac{X-F_T}{(1+R_f)^{T}} = P_0$$ 计算

Binomial Model

股票二叉树

$$\pi_u = \frac{1+R_f-d}{u-d}$$

value of an option: $c = \left[\pi_u C_1^+ + \pi_d C_1^-\right] \times \frac{1}{(1+R_f)^T}$

➡ 计算
- Call & Put
- American & European

⬇

Arbitrage With A One-Period Binomial Model

- concept of ***arbitrage***
  - Do not use your own money
  - Do not take any price risk
  - generate positive CF

Hedge Ratio(h)

➡ $h = \frac{C^+ - C^-}{S^+ - S^-}$

single-period call option valuation equation

$$C = hS + PV(-hS^- + C^-)$$

利率二叉树

与股票二叉树区别 ➡
- interest rate tree will be given on the exam.
- interest rates at each node are one-year forward rates.
- π and 1−π, are always 0.5.

Interest rate option估值

计算，求cap & floor期权价格

Call payoff = notional principal ×[Max(0 , reference rate – X)]

Put payoff = notional principal ×[Max(0 , X – reference rate)]

BSM Model

BSM

$$C_0 = [S_0 \times N(d_1)] - [X \times e^{-R_f^c \times T} \times N(d_2)]$$ 计算

assumptions ★★

- ***Return*** of the underlying asset → ***lognormal*** distribution.
- The (continuous) risk-free rate is known and constant.
- Volatility of the underlying asset is known and constant.
- The markets are frictionless.
- There are no cash flows on the underlying asset.
- The options valued are European options.

Interpret The Components Of The BSM

- the PV of the expected option payoff at expiration
- Call=Long N(d1) stock, short N(d2) bond, Put= Short N(-d1) stock, long N(-d2) bond
- Dynamically managed portfolio of stock and zero coupon bonds

Describe The Usage of The BSM

Carry Benefit-Adjusted BSM Model

→ ***substitute*** $S_0 \times e^{-\delta T}$ for S_0

Options On Currencies

$$C_0 = S_0 e^{-r(B)T} N(d_1) - X e^{-r(P) \times T} N(d_2)$$

The Black Model

$$C_0 = e^{-R_f^c T}[F_T N(d_1) - X N(d_2)]$$

Equivalencies in Interest Rate Derivative

- ***Long FRA*** = long interest rate call + short interest rate put
- ***Short FRA***= short interest rate call + long interest rate put
- ***Payer swap*** = a long cap + a short floor
- ***Receiver swap*** = a short cap + a long floor
- ***Receiver swap*** = Long receiver swaption + short payer swaption
- ***Payer swap*** = Long payer swaption + short receiver swaption
- ***Long callable bond*** = Long option free bond + a short receiver swaption

Option Greeks ★★

Sensitivity Factor	Input	Calls	Puts
Delta	Underlying price (S)	Delta~(0, $e^{-\delta T}$)	Delta~(-$e^{-\delta T}$,0)
Vega	Volatility (σ)	Vega>0	Vega>0
Rho	Risk-free rate (r)	Rho>0	Rho<0
Theta	Passage of Time (T)	Theta<0	Theta < 0*
	Strike price (X)	Negatively related	Positively related

➡ **Call**
- Deep in→1
- Deep out→0

Gamma→>0, at the money最大

Dynamic Hedge→计算★

➡ ***implied volatility***

If an option is ***overvalued***, implied volatility is too ***high***

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DERIVATIVES STRATEGIES

Derivatives Strategies

Changing Risk Exposures

With SWAP

- **Interest Rate Swap→** modify the duration
  - $D_{pay\text{-}floating} = D_{fixed} - D_{floating} > 0$ →*Increase* duration
  - $D_{pay\text{-}fix} = D_{floating} - D_{fixed} < 0$ →*Decrease* duration
- **Currency Swap→** 改变负债货币
- **Equity Swap→** 改变组合构成

With Futures

- **Interest Rate Futures →** **modify the duration** of a portfolio
- **Currency Futures →** ***hedge an asset or liability*** in a foreign currency
- **Stock Index Futures →** change the exposure of equities in a portfolio

Synthetic Positions

Synthetic Stock	Long Stock = long call +short put
Synthetic Puts and Calls	Synthetic call= long stock+ long put Synthetic put= long call+ short stock
Synthetic Assets with Forward/Futures	long futures + risk free asset = long Stock *long* Stock + *short* futures = risk free asset

Option Strategies for Equity Portfolios ★★

考法 → 构成
Max Profit & Loss
Breakeven point

Covered Call & Protective Put

- **Covered call** = short call + long stock → Profit = $(S_T - S_0) - [\max\{0, (S_T - X)\} - C]$
- **Protective Put** = long stock + long put → Profit = $(S_T - S_0) + [\max\{0, (X - S_T)\} - P]$

Option Spread

一个strategy只用call或者put，而不是二者混用

Bull spread	Call	Bull Call Spread = long call at X_L + short call at X_H → Profit = $[\max\{0, (S_T - X_L)\} - C_L] - [\max\{0, (S_T - X_H)\} - C_H]$
	Put	Bull Put Spread = long put at X_L + short put at X_H →Profit = $[\max\{0, (X_L - S_T)\} - P_L] - [\max\{0, (X_H - S_T)\} - P_H]$
Bear spread	Call	Bear Call Spread = short call at X_L + long call at X_H →Profit = $-[\max\{0, (S_T - X_L)\} - C_L] + [\max\{0, (S_T - X_H)\} - C_H]$
	Put	Bear Put Spread = short put at X_L + long put at X_H → Profit = $-[\max\{0, (X_L - S_T)\} - P_L] + [\max\{0, (X_H - S_T)\} - P_H]$
Calendar Spreads	Call/Put	Long calendar spread: buys the more distant option, short the near-term option. Short calendar spread: buy a near-term option and sell a longer-dated one

Combinations of Calls and Puts

Straddle	long straddle = long call + long put • This strategy is profitable when the stock price ***moves strongly in either direction***. This strategy ***bets on volatility***.
	short straddle = short call + short put • bets on ***little movement in the stock***
Collar	Collar = protective put + covered call = long stock + short call + long put • If the premium of the two are equal, it is called a ***zero-cost collar.***

Option Strategies for Equity Portfolios ★★

Investment Objective

- ***Consistent*** with the investment objective
- Depends on both ***market direction*** and ***volatility***

Breakeven Price Analytics

$$\sigma_{annual} = \%\Delta P \times \sqrt{\frac{252}{trading\ days\ until\ maturity}}$$

Strategy Selection

Future Market Condition	Option Strategy
strong bullish(bearish)	long calls(puts)
average bullish(bearish)	long calls and short puts
weak bullish(bearish)	short puts(calls)
high(low) of future volatility	long(short) straddle


Thank
You!