AG313 Treasury Management & Derivatives Coursework Summary

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1 Derivatives

1.1 Options

1.1.1 Option vs. Forward Contracts

- *Option*: Right to buy/sell, in future, at rate (no future exchange rate saftey)
- *Future*: Obligation to buy/sell, in future, at rate (future exchange rate safety)

1.1.2 Spot vs. Future/Forward Prices

- *Spot Price*: immediate delivery $(\mathrm{S_0}, \mathrm{S_T})$
- *Future/Forward Price*: future delivery price (locked-in today) $(\mathrm{F_0}, \mathrm{F_T})$
  - $\mathrm{F_T} < \mathrm{S_T}$: Forward = Spot grossed up @ r
  - Spot expected to be > r growth

1.1.3 Short vs. Long Positions

- *Short*: Sell shares now $(\mathrm{S_0} = \text{Spot})$, buy later $(\mathrm{S_T} = \text{Delivery})$
  - Expect fall in share price, in future
  - Futures price (↑), loss
  - Profit = $\mathrm{S_0} - \mathrm{K}$
- *Long*: Buy shares now
  - Expect rise in share price, in future
  - Futures price (↑), gain
  - Profit = $\mathrm{K} - \mathrm{S_T}$

1.1.4 Call vs. Put Options

- "At The Money": $\mathrm{S_T} = \mathrm{K}$
- *Call*: Agreement to buy at specified time and Strike Price
  - Profit ("In The Money"): $\mathrm{S_T} > \mathrm{K}$
  - Profit = $\mathrm{N(S_T - K)}$ – Cost; Cost = $\mathrm{N(C_0)}$
- *Put*: Agreement to sell at specified time and Strike Price

  - Profit ("In The Money"): $\mathrm{K} > \mathrm{S_T}$
  - $\mathrm{Profit} = \mathrm{Cost} - \mathrm{N}(\mathrm{K} - \mathrm{S_T})$; $\mathrm{Cost} = \mathrm{N}(\mathrm{P_0})$

- European Option: exercised only on expiration
- American Option: exercised any time up-to expiration and expiration

1.1.5 Exchange vs. Over-the-Counter

- *Exchange*: $60tn valuation; more standardized and regulated
  - Trades Futures contracts
- *Over-the-Counter*: $600tn valuation; higher credit risk, higher prices
  - Trades Forward contracts

1.2 Futures Markets

- Regulated by Commodities Futures Trading Commission (CFTC)
- *Clearing House*: always used in Futures Market to ensure payment method
- *Central Clearing Parties*: similar job to the above
- *Haircut*: difference between Market Value and Collateral usage of an asset
- *Bilateral Clearing*: group agree terms to trade w/ eash-other to minimise risk
- *Limit Order*: trader identifies worst at which trade can take place

1.2.1 Forward vs. Future

- Futures based on a shorter period than Forwards
- Futures usually don't have final cash settlements

1.2.2 Margin 'Curtain Call' Call

- Broker's demand that investor adds funds to retain minimum value of fund, daily
- Options up-to 9 months must be bought in full; post-9-months margin can be taken
- The seller posts the margin
- Margin acounts adjusted daily for gain/loss
- Reduce systematic risk $\rightarrow$ ensure funds available $\rightarrow$ reduce risk of back-out
- Margin Call when: Loss $>$ (Initial Margin $-$ Maintenance Margin)

  α If Short: ea. \$1 rise in price is a \$1 per-unit loss; find = to above

  β Add the per-unit rise to the per-unit price

  γ If Long: ea. \$1 rise in price is a \$1 per-unit gain; find = to above

  δ Add the per-unit rise to the per-unit price

1.2.3 Corn Futures Contract

- Initiated by party w/ Short Position; 'Notice of Intention' [to deliver]
- Exchange goes through procedure of choosing party to take Long Position

1.2.4 Hedging vs. Speculating

- *Hedging*: e.g. expect volatility, perhaps price rise to take Futures contract to lock in a better price now
- *Speculating*: e.g. act upon volatility expectation perhaps where there's expected fall in price, take a Short position and buy back for profit
- Hedgers hold Long, Speculators hold Short: $(\mathrm{F_T} > \mathrm{S_T})$

1.3 Forward & Futures Prices

- Future Price quoted as no. of US$ per-unit of foreign currency
- Lenders cannot issue instructions
- *Investment Asset*: traded but not usually phyisically usable or tangible
- *Consumption Asset*: traded and usable for consumption (e.g. Copper)
- *Convenience Yield*: 0/(+), measures benefit of owning rather than Forward/Future
  - Having real value vs. locked-in F value
  - Investment: 0
  - Consumption: (+)
  - Increase: F as % of S $\downarrow$; more convenieint to own
  - Decrease: F as % of S $\uparrow$; more convenient to F
- *Dividend Yield*: Div.'s as a % of stock price at t of Div. payment
- *Contango*: $F_T > S_T$ abnormally

1.3.1 Shorting With Dividends

1. Sell now (S_0), buy later (S_T) (Gain-Per-Share = $S_0 - S_T$)
2. Pay Dividend (Gain-Per-Share = $S_0 - S_T -$ Div.)

1.3.2 Spot-to-Forward Price

$$F_T = S_0 e^{rT}$$

$$F_T = (S_0 - \text{Income})e^{rT}$$

$$\text{Income} = Y_t e^{-rT} + ... + Y_{t+n} e^{-rT}$$

$$F_T = ER_0 e^{(r_1 - r_2)T}$$

1.4 Hedging Strategies With Futures

- Futures delivery month should be as close as possible to purchase of asset
- "Tailing the Hedge": corrects for daily settlement
- Hedging Futures leads to predictability

$$\text{Basis} = \text{Spot}_{\text{At Close}} - \text{Futures}_{\text{At Close (For Maturity)}}$$

$$\text{Price Recieved} = \text{Basis} + \text{Futures}_{\text{At Purchase (ForMaturity)}}$$

$$\text{Optimal Hedge Ratio} = \rho_{\text{A,B}} \left(\frac{\sigma_{\text{A}}}{\sigma_{\text{B}}} \right)$$

"Movement in S price to movement in F price"

$$\text{Optimal Folios} = (\beta_{\text{Current}} - \beta_{\text{Desired}}) \left(\frac{\text{V}_{\text{Folio}}}{\text{F}_0\text{F}_\text{N}} \right)$$

$$\text{If } (+)\text{: Short}$$
$$\text{If } (-)\text{: Long}$$

$$\text{P}_{\text{Total}} = \text{w}_{\text{Hedged}}\text{P}_{\text{Hedged}} + \text{w}_{\text{Not}-\text{Hedged}}\text{P}_{\text{Not}-\text{Hedged}}$$

Where:

$$\text{Given } \text{S}_0, \text{F}_0, \text{S}_\text{T}, \text{F}_\text{T}$$
$$\text{P}_{\text{Hedged}} = \text{S}_\text{T} - (\text{F}_0\text{F}_\text{T})$$
$$\text{P}_{\text{Not}-\text{Hedged}} = \text{S}_\text{T}$$

1.5 Option Market Mechanics

- *Option Class*: All Calls or Puts on a stock
- *Option Series*: All options on a certain stock type
- *LEAPS*: Long-Term Equity Anticipation Securities w/ long maturities
- *Stock Split*
  - E.g.: N = 100, K = 20, 2-for-1 Split;
  - Ans.: $N = 2(100) = 200$, $K = \frac{1}{2}(20) = 10$
- *Stock Dividend*
  - E.g.: N = 100, K = 20, Div. = 25%;
  - Ans.: $N = 1.25(100) = 125$, $K = \frac{4}{5}(20) = 16$
- *Cash Dividend*
  - No effect
- Option Value = Time Value + Intrinsic Value
  - At-the-Money Time Value = 0 so Option Value = Intrinsic Value
  - Call: $(S_T - K, 0)$
  - Put: $(K - S_T, 0)$

1.6 Option Pricing

1.6.1 Binomial Option Tree: European Put

Step 1: Probability

$$\mathrm{u} = \mathrm{e}^{\sigma\sqrt{\Delta \mathrm{t}}}$$

$$\mathrm{d} = \mathrm{e}^{-\sigma\sqrt{\Delta \mathrm{t}}} = \frac{1}{\mathrm{u}}$$

$$\mathrm{p} = \frac{\mathrm{e}^{\mathrm{r}\Delta \mathrm{t}} - \mathrm{d}}{\mathrm{u} - \mathrm{d}} = \text{Risk Neutral Probability of Up Movement}$$

$$(1 - \mathrm{p}) = \text{Risk Neautral Probability of Down Movement}$$

Step 2: Share Value

$$\mathrm{S}_{\mathrm{u/d}} = \text{Value of Stock Upon Increase/Decrease}$$

$$\mathrm{S}_{\mathrm{u}} = \mathrm{Pu}$$

$$\mathrm{S}_{\mathrm{d}} = \mathrm{Pd}$$

$$\mathrm{S}_{\mathrm{u,u}} = \mathrm{Pu}^2$$

$$\mathrm{S}_{\mathrm{u,d}} = \mathrm{Pud}$$

$$\mathrm{S}_{\mathrm{d,d}} = \mathrm{Pd}^2$$

Step 3: Put Value

$$\mathrm{P}_{\mathrm{u/d}} = \text{Value of Option Upon Increase/Decrease}$$

$$\mathrm{P}_{\mathrm{u,u}} = 0$$

$$\mathrm{P}_{\mathrm{u,d}} = \mathrm{K} - \mathrm{S}_{\mathrm{u,d}}$$

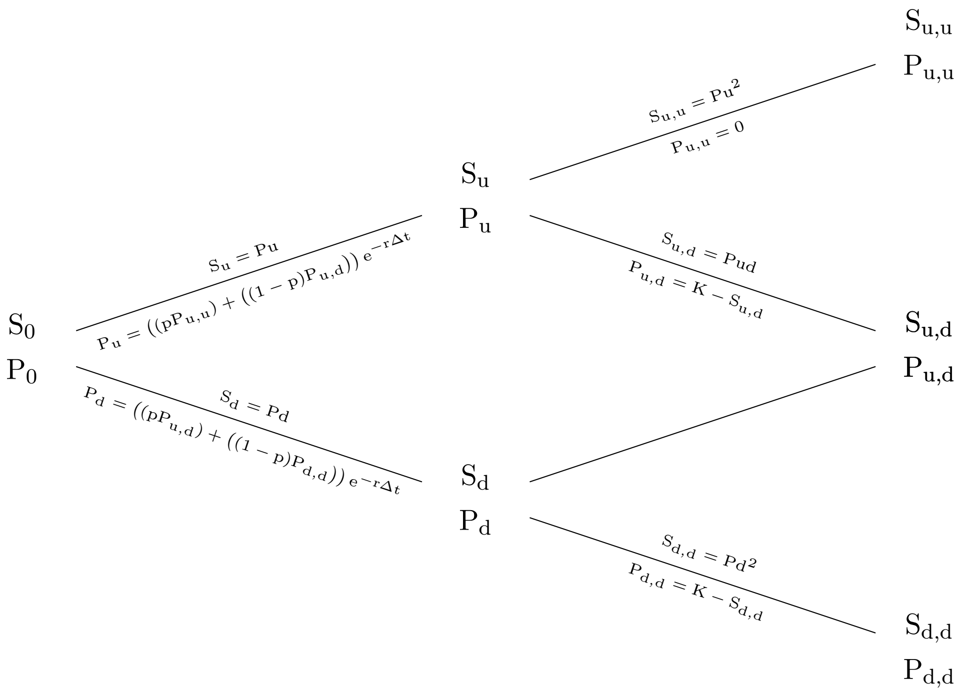
$$\mathrm{P}_{\mathrm{d,d}} = \mathrm{K} - \mathrm{S}_{\mathrm{d,d}}$$

$$\mathrm{P}_{\mathrm{u}} = ((\mathrm{p}\mathrm{P}_{\mathrm{u,u}}) + ((1 - \mathrm{p})\mathrm{P}_{\mathrm{u,d}}))\,\mathrm{e}^{-\mathrm{r}\Delta \mathrm{t}}$$

$$\mathrm{P}_{\mathrm{d}} = ((\mathrm{p}\mathrm{P}_{\mathrm{u,d}}) + ((1 - \mathrm{p})\mathrm{P}_{\mathrm{d,d}}))\,\mathrm{e}^{-\mathrm{r}\Delta \mathrm{t}}$$

$$\mathrm{P}_{0} = ((\mathrm{p}\mathrm{P}_{\mathrm{u}}) + ((1 - \mathrm{p})\mathrm{P}_{\mathrm{d}}))\,\mathrm{e}^{-\mathrm{r}\Delta \mathrm{t}}$$

Step 4: The Binomial Tree



1.6.2 Binomial Option Tree: Converting to American Put

$$P_{d_A} = \max\{K - S_d, P_d\}$$

$$P_{d_A} = \text{Larger Outcome of Either } (K - S_d) \text{ or } (P_d)$$

$$P_{u_A} = \text{Remains Same}$$

$$P_{0_A} = ((pP_{u_A}) + ((1-p)P_{d_A}))\, e^{-r\Delta t}$$

Reform Binomial Tree

1.7 Stock Options

- Stock Price (↑): Call (↑); Put (↓)
- Strike Price (↑): Call (↓); Put (↑)
- Volatility (↑): Call Payoff (↑); Put Payoff (↑)
- Dividends (↑): Stock Price (↓); Call (↓); Put (↑)
- Interest Rate (↑): Call (↑); Put (↓)
- Time-Maturity (↑): European Options (↑ / ↓)

1.7.1 Call Lower-Bound

$$\mathrm{S_0 - Ke^{-rT}}$$

1.7.2 Put Lower-Bound

$$\mathrm{Ke^{-rT} - S_0}$$

1.7.3 Put-Call Parity w/o Dividend (or 0 Interest)

$$\mathrm{C_0 + Ke^{-rT} = P_0 + S_0}$$

$$\mathrm{C_0 + K = P_0 + S_0}$$

1.7.4 Put-Call Parity w/ Divided

$$\mathrm{C_0 + Ke^{-rT} = P_0 + (S_0 - Div.)}$$

1.7.5 Black & Scholes Models

$$\mathrm{d_1} = \frac{\ln\left(\frac{\mathrm{S}}{\mathrm{K}}\right) + \mathrm{T}\left(\mathrm{r} + \frac{\sigma^2}{2}\right)}{\sigma\sqrt{\mathrm{T}}}$$

$$\mathrm{d_2 = d_1} - \sigma\sqrt{\mathrm{T}}$$

$$\mathrm{C_0 = S(N(d_1)) - Ke^{-rT}(N(d_2))}$$

$$\mathrm{C_0 = Se^{-yT}(N(d_1)) - Ke^{-rT}(N(d_2))}$$

$$\mathrm{P_0 = K(1 - N(d_1)) - Se^{-rT}(1 - N(d_2))}$$

2 Treasury Management

2.1 Foreign Exchange Market

Domestic in terms of foreign; foreign in terms of domestic

$$\text{Spread} = \frac{\text{Ask} - \text{Bid}}{\text{Ask}}$$

$$\text{Direct Quotation} = \pounds/\$ = \frac{1}{\$/\pounds}$$

$$\text{Indirect Quotation} = \$/\pounds = \frac{1}{\pounds/\$}$$

$$\text{Cross Rate} = \$/\pounds = \text{EUR}/\pounds\frac{1}{\text{EUR}/\$}$$

2.2 Interest Parity Relationships

2.2.1 Interest Rate Arbitrage

$$\mathrm{A_n} = \left(\frac{\mathrm{A_h}}{\mathrm{S}}\right)(1 + \mathrm{i_f})(\mathrm{S}(1 + \mathrm{p}))$$

$$\mathrm{S}(1 + \mathrm{p}) = \mathrm{F}$$

$$\mathrm{A_{h,n}} = \text{Home/New Home Currency}$$

$$\mathrm{i_{h,f}} = \text{Home/Foreign Currency}$$

$$\mathrm{S} = \text{Spot Exchange Rate} = \text{N of } \pounds \text{ Per Unit of } \$$$

$$\mathrm{F} = \text{Forward (Locked) Exchange Rate} = \text{N of } \pounds \text{ Per Unit of } \$$$

$$\mathrm{p} = \text{Forward Premium} = \text{Amount By Which F is} \uparrow / \downarrow \text{Than S}$$

$$\text{Convert To \$:} \left(\frac{\mathrm{A_h}}{\mathrm{S}}\right)$$

$$\text{End of Period \$ Principal \& Interest :} \left(\frac{\mathrm{A_h}}{\mathrm{S}}\right)(1 + \mathrm{i_f})$$

$$\$ \text{ Principal \& Interest Back to } \pounds: \left(\frac{A_h}{S}\right)(1+i_f)F$$

2.2.2 Interest Rate No-Arbitrage

$$A_h(1+i_h) = A_h(1+i_f)(1+p)$$

$$A_h(1+i_h) = \text{Investing w/ Home Interest} = \text{Investing w/ Foreign Interest w/ p}$$

$$\therefore p = \frac{(1+i_h)}{(1+i_f)} - 1 \therefore p \approx i_h - i_f$$

2.2.3 Absolute PPP

$$S_f^d = \frac{P_s^d}{P_s^f}$$

$$\text{As}: \; P_s^d = S_f^d P_s^f$$

2.2.4 Relative PPP w/ Inflation

$$P_h(1+\pi_h)$$

$$P_f(1+\pi_f)$$

If $\pi_h > \pi_f$: PP is greater when buying foreign goods $\rightarrow$ foreign cheaper
If $\pi_h < \pi_f$: PP is greater when buying domestic goods $\rightarrow$ domestic cheaper

Adjust for Change in Currency:

$$P_f(1+\pi_f)(1+e_f)$$

e_f = % Change Per Unit of Foreign Currency In Domestic Currency

Hence:

$$P_h(1+\pi_h) = P_f(1+\pi_f)(1+e_f)$$

$$e_f = \frac{P_h(1+\pi_h)}{P_f(1+\pi_f)} - 1 = \frac{(1+\pi_h)}{(1+\pi_f)}$$

Given $P_h = P_f$:
If $\pi_h > \pi_f$: e_f (+): foreign should appreciate; domestic depreciate
If $\pi_h < \pi_f$: e_f (−): foreign should depreciate; domestic appreciate

For Relatively Low Inflation:

$$\mathrm{e_f} = \frac{(1+\pi_\mathrm{h})}{(1+\pi_\mathrm{f})} - 1 \approx (\pi_\mathrm{h} - \pi_\mathrm{f})$$

2.3 Exchange Exposure

2.3.1 Variance of Two-Asset Folio

$$\sigma^2_{\mathrm{x,y}} = \sigma^2_{\mathrm{x}} + \sigma^2_{\mathrm{y}} + 2(\mathrm{cov}_{\mathrm{x,y}})$$

Hence:

$$\mathrm{p} = \{\mathrm{x}, \mathrm{y}\}$$

$$\mathrm{cov}_{\mathrm{x,y}} = \rho_{\mathrm{x,y}}\sigma_{\mathrm{x}}\sigma_{\mathrm{y}}$$

$$\sigma^2_{\mathrm{p}} = \sigma^2_{\mathrm{x}} + \sigma^2_{\mathrm{y}} + 2(\rho_{\mathrm{x,y}}\sigma_{\mathrm{x}}\sigma_{\mathrm{y}})$$

2.3.2 Variance of Three-Asset Folio

$$\sigma^2_{\mathrm{p}} = \sigma^2_{\mathrm{x}} + \sigma^2_{\mathrm{y}} + \sigma^2_{\mathrm{z}} + 2(\rho_{\mathrm{x,y}}\sigma_{\mathrm{x}}\sigma_{\mathrm{y}}) + 2(\rho_{\mathrm{x,z}}\sigma_{\mathrm{x}}\sigma_{\mathrm{z}}) + 2(\rho_{\mathrm{y,z}}\sigma_{\mathrm{y}}\sigma_{\mathrm{z}})$$

2.3.3 Economic Exposure

$$\mathrm{V_{MNC}} = \sum \frac{\sum(\mathrm{E(CF_{j,t})E(ER_{j,t})})}{(1+\mathrm{k})^{\mathrm{t}}}$$

Where:

$$\mathrm{E(CF_{j,t})} = \text{Expected CF in Currency j Recieved At End of Period t}$$

$$\mathrm{E(ER)_{j,t}} = \text{Expeced ER of Currency j At End of Peiod t}$$

$$\mathrm{k} = \text{Weighted Average Cost of Capital (WACC) of MNC}$$

2.4 Value of A Multinational Corporation

- Value of Parent Company (p, perhaps in USD)
- Value of Subsidiary 1 (s1, perhasp in EUR)
- Value of Subsidiary 2 (s2, perhaps in GBP)

2.4.1 Basic Values

$$\mathrm{V_t} = \frac{\mathrm{E(C_{t+1})}}{(1+\mathrm{r})^{\mathrm{t+1}}} + \frac{\mathrm{E(C_{t+2})}}{(1+\mathrm{r})^{\mathrm{t+2}}} + \frac{\mathrm{E(C_{t+3})}}{(1+\mathrm{r})^{\mathrm{t+3}}}$$

Value of Cash Flows in USD *Functional Currency*:

$$\mathrm{V_{t,p}} = \frac{\mathrm{E(C_{t+1,\$})}}{(1+\mathrm{r_\$})^{\mathrm{t+1}}} + \frac{\mathrm{E(C_{t+2,\$})}}{(1+\mathrm{r_\$})^{\mathrm{t+2}}} + ... + \frac{\mathrm{E(C_{t+n,\$})}}{(1+\mathrm{r_\$})^{\mathrm{t+n}}}$$

Value of Cash Flows in EUR:

$$\mathrm{V_{t,s1}} = \frac{\mathrm{E(C_{t+1,EUR})}}{(1+\mathrm{r_{EUR}})^{\mathrm{t+1}}} + \frac{\mathrm{E(C_{t+2,EUR})}}{(1+\mathrm{r_{EUR}})^{\mathrm{t+2}}} + ... + \frac{\mathrm{E(C_{t+n,EUR})}}{(1+\mathrm{r_{EUR}})^{\mathrm{t+n}}}$$

Value of Cash Flows in GBP:

$$\mathrm{V_{t,s2}} = \frac{\mathrm{E(C_{t+1,\pounds})}}{(1+\mathrm{r_\pounds})^{\mathrm{t+1}}} + \frac{\mathrm{E(C_{t+2,\pounds})}}{(1+\mathrm{r_\pounds})^{\mathrm{t+2}}} + ... + \frac{\mathrm{E(C_{t+n,\pounds})}}{(1+\mathrm{r_\pounds})^{\mathrm{t+n}}}$$

2.4.2 Value Exchnage Conversion

Value of Cash Flows in USD *Functional Currency*:

$$\mathrm{V_{t,p}} = \frac{\mathrm{E}\left(\mathrm{C_{t+1,\$}}\left(\frac{\$}{\$}\right)_{\mathrm{t+1}}\right)}{(1+\mathrm{r_\$})^{\mathrm{t+1}}} + \frac{\mathrm{E}\left(\mathrm{C_{t+2,\$}}\left(\frac{\$}{\$}\right)_{\mathrm{t+2}}\right)}{(1+\mathrm{r_\$})^{\mathrm{t+2}}} + ... + \frac{\mathrm{E}\left(\mathrm{C_{t+n,\$}}\left(\frac{\$}{\$}\right)_{\mathrm{t+3}}\right)}{(1+\mathrm{r_\$})^{\mathrm{t+n}}}$$

Value of Cash Flows in USD *Converted from EUR*:

$$\mathrm{V_{t,p}} = \frac{\mathrm{E}\left(\mathrm{C_{t+1,EUR}}\left(\frac{\$}{\mathrm{EUR}}\right)_{\mathrm{t+1}}\right)}{(1+\mathrm{r_\$})^{\mathrm{t+1}}} + \frac{\mathrm{E}\left(\mathrm{C_{t+2,EUR}}\left(\frac{\$}{\mathrm{EUR}}\right)_{\mathrm{t+2}}\right)}{(1+\mathrm{r_\$})^{\mathrm{t+2}}} + ...$$
$$+ \frac{\mathrm{E}\left(\mathrm{C_{t+n,EUR}}\left(\frac{\$}{\mathrm{EUR}}\right)_{\mathrm{t+3}}\right)}{(1+\mathrm{r_\$})^{\mathrm{t+n}}}$$

Value of Cash Flows in USD *Converted from GBP*:

$$V_{t,p} = \frac{E\left(C_{t+1,£}\left(\frac{\$}{£}\right)_{t+1}\right)}{(1+r_{\$})^{t+1}} + \frac{E\left(C_{t+2,£}\left(\frac{\$}{£}\right)_{t+2}\right)}{(1+r_{\$})^{t+2}} + ... + \frac{E\left(C_{t+n,£}\left(\frac{\$}{£}\right)_{t+3}\right)}{(1+r_{\$})^{t+n}}$$

2.4.3 Value of Each Domestic/Foreign Operation

Hence *Total Value of Parent Corporation (p)*:

$$V_{t,p} = \sum_{i=1}^{n} \frac{E(C_{t+i,\$})}{(1+r_{\$})^{t+i}}$$

Hence *Total Value of European Subsidiary (s1)*:

$$V_{t,s1} = \sum_{i=1}^{n} \frac{E\left(C_{t+i,EUR}\left(\frac{\$}{EUR}\right)_{t+i}\right)}{(1+r_{\$})^{t+i}}$$

Hence *Total Value of British Subsidairy (s2)*:

$$V_{t,s2} = \sum_{i=1}^{n} \frac{E\left(C_{t+i,£}\left(\frac{\$}{£}\right)_{t+i}\right)}{(1+r_{\$})^{t+i}}$$

2.4.4 Total Value of Multinational Corporation

Hence *Total Value of Multinational Corporation*:

$$V_p = V_{s1} + V_{s2}$$

Hence *For 3 Currency Example Over n Periods (i)*:

$$V_{t,MNC} = \sum_{i=1}^{n} \frac{E(C_{t+i,\$})}{(1+r_{\$})^{t+i}} + \sum_{i=1}^{n} \frac{E\left(C_{t+i,EUR}\left(\frac{\$}{EUR}\right)_{t+i}\right)}{(1+r_{\$})^{t+i}} + \sum_{i=1}^{n} \frac{E\left(C_{t+i,£}\left(\frac{\$}{£}\right)_{t+i}\right)}{(1+r_{\$})^{t+i}}$$

Hence *Generalised for 3 Unknown Currencies Over n Periods (i)*:

$$V_{t,MNC} = \sum_{i=1}^{n} \frac{E\left(C_{t+i,1}(ER_1)_{t+i}\right)}{(1+r_{\$})^{t+i}} + \sum_{i=1}^{n} \frac{E\left(C_{t+i,2}(ER_2)_{t+i}\right)}{(1+r_{\$})^{t+i}} + \sum_{i=1}^{n} \frac{E\left(C_{t+i,3}(ER_3)_{t+i}\right)}{(1+r_{\$})^{t+i}}$$

Hence *Generalised for n Unkown Currencies (j) Over n Periods (i)*:

$$\mathrm{V_{t,MNC}} = \sum_{\mathrm{j=1}}^{\mathrm{n}} \left(\sum_{\mathrm{i=1}}^{\mathrm{n}} \frac{\mathrm{E\,(C_{t+i,j}(ER_j)_{t+i})}}{\mathrm{(1 + r_\$)^{t+i}}} \right)$$

2.4.5 How Can The Value Change?

If $\mathrm{C_{t+i,j}} < \mathrm{E(C_{t+i})_j}$: $\mathrm{V_{t,MNC}}$ lower than expected *country business risk*
If $\mathrm{r_\$} > \mathrm{Er_\$}$: $\mathrm{V_{t,MNC}}$ lower than expected *country policy risk*
If $\mathrm{(ER_\$)_{t+i}} < \mathrm{(ER_£)_{t+i}}$: $\mathrm{V_{t,MNC}}$ lower than expected *foreign exchange risk (where \$ is domestic)*

2.5 Interest Rate Risk

- $\frac{1}{100}$ of a %pt. is a 'Basis Point'
- Must convert period to days

$$\mathrm{R} = \text{Simple Interest Rate}$$

$$\mathrm{r} = \frac{\mathrm{R}}{\mathrm{m}} = \text{Periodic Interest Rate}$$

$$\text{“m periods per n”}$$

$$(1+\mathrm{r})^{\mathrm{mn}} - 1 = \text{Compound Interest Rate}$$

$$\mathrm{EAR} = (1+\mathrm{r})^{\frac{\text{year}}{\text{days}}} - 1$$

2.5.1 Duration

$$\Delta \mathrm{B} = -\mathrm{DB}\Delta \mathrm{y}$$

$$\mathrm{B} = \sum \frac{\mathrm{CF_t}}{(1+\mathrm{y})^{\mathrm{t}}}$$

$$\mathrm{D} = \sum \mathrm{t}\left(\frac{\frac{\mathrm{CF_t}}{(1+\mathrm{y})^{\mathrm{t}}}}{\mathrm{P}}\right) = \sum \mathrm{tw_t}$$

$$\mathrm{y} = \text{Yield on Bond}$$

$$\mathrm{P} = \text{Bond Price}$$

$$\mathrm{D_{Zero-Coupon}} = \text{Maturity} = \mathrm{T}$$

$$\text{Constant Maturity}:\ \mathrm{D}(\uparrow),\ \mathrm{CF}(\downarrow)$$

$$\text{Constant Coupon}:\ \mathrm{D}(\uparrow),\ \mathrm{T}(\uparrow)$$

$$\text{Constant All Other}:\ \mathrm{D}(\uparrow),\ \mathrm{y}(\downarrow)$$

2.5.2 Forward Rate Agreements

$$\text{Payoff} = (\text{Notional Amount})\,(\text{LIBOR} - \text{Agreed Upon Rate})\left(\frac{\mathrm{m}}{360}\right)$$

$$\text{Payoff} = (\text{Notional Amount})\left(((\text{LIBOR}) - \text{Agreed Upon Rate})\frac{\left(\frac{\text{m}}{360}\right)}{(1+\text{LIBOR})\left(\frac{\text{m}}{360}\right)}\right)$$

2.5.3 Interest Rate Option

$$\text{Payoff}_{\text{Call}} = (\text{Notional Amount})\left(\text{Max}\,(0, \text{LIBOR} - \text{X})\left(\frac{\text{m}}{360}\right)\right)$$

$$\text{If LIBOR} > \text{X}: \text{ Exercise}$$

$$\text{Payoff}(\uparrow),\ \text{LIBOR}(\uparrow)$$

$$\text{Protection Against Rising i (e.g. future borrowing)}$$

$$\text{Payoff}_{\text{Put}} = (\text{Notional Amount})\left(\text{Max}\,(0, \text{X} - \text{LIBOR})\left(\frac{\text{m}}{360}\right)\right)$$

$$\text{If LIBOR} < \text{X}: \text{ Exercise}$$

$$\text{Payoff}(\uparrow),\ \text{LIBOR}(\downarrow)$$

$$\text{Protection Against Falling i (e.g. future investing)}$$